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Ecological Sanitation – A Logical Choice?

The Development of the Sanitation Institution in a World Society



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ABSTRACT

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Ecological Sanitation - A Logical Choice? The Development of the Sanitation Institution in a World Society

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Sustainability, encompassing ecological, economic as well as socio-cultural aspects, has become a driving force for many political and administrative decisions. It is no longer enough to follow old practices or rely on profit margins – it is necessary to consider the needs of society and nature in a more holistic way as a larger whole. Sustainability is the key word also in terms of sanitation; ecological sanitation, or ecosan for short, has come to mark the sustainable approach to handling human excreta.

In 2014, there are still approximately 2.5 billion people in the world without access to adequate sanitation; 1.1 billion practice open defecation. Lack of sanitation is often – but not necessarily – linked to lack of clean drinking water and poor hygiene. However, poor wastewater treatment also occurs in more developed countries as well as in times of crisis. In the case of natural disasters, even waterborne sanitation, which is often considered the norm, does not prevent the risk of contamination from pathogens. Ecological sanitation aims at a closed cycle of nutrients and absence of water; dry toilets, composting and urine diversion help to return nutrients back into the soil.

Based on these challenges, it is necessary to examine alternatives to the current toilet institution that considers waterborne sanitation as the norm. This dissertation explores the feasibility of ecological sanitation as a potential alternative to the mainstream option and the aim is to discover which issues affect the development and change of the current waterborne toilet institution. From a multi- and interdisciplinary point of view, the dissertation determines the various aspects affected by ecosan, such as water and environment, health, culture, education, agriculture, business and technology, and from these points of view develops future scenarios for sustainable sanitation practices. Technology is here defined beyond artefacts and processes encompassing also knowhow as well as the sociotechnical systems of use, including legislation, culture and practices.

The data collected for this research includes expert interviews (n=11), case studies from Ethiopia, Finland, New Zealand and Zambia, and literature review including various policy documents and legislation of the aforementioned case countries to shed light to the current state of ecological sanitation and how it is taken into account from a legal perspective. In addition, a two-round consensus-Delphi survey (n₁=44, n₂=22) together with

theme seminars was conducted among Finnish experts to determine the future potential of ecological sanitation.

Through qualitative data analyses, the potential futures and desirable outcomes are mapped with the help of futures research and environmental scanning. The overall challenge of potentially changing the waterborne toilet institution is discussed in the light of the World Polity Theory – with the understanding that global norms are valid everywhere and that change eventually must start from intergovernmental actors rather than political decision makers.

This research brings more insight to the relatively unknown and overlooked subject of ecological sanitation. The integrated approach offers new insight into sustainable sanitation practices and closed loop approach from view points of the various sectors of society, including social, economic and ecological aspects. The undisputed challenges of inadequate sanitation facilities faced by 2.5 billion people worldwide are generally not recognised in scientific literature, although several invaluable studies have contributed to the field. Still, concrete results for improvement are still required.

The results of this study find that ecological sanitation must be approached from a multidisciplinary point of view in order to understand the variety of sectors impacted by these sustainable practices. As a conclusion it can be stated that the traditional norms in waterborne sanitation are difficult to change but the pressure of limited phosphorus resources and deteriorating or non-existing infrastructure require alternative solutions to the norm. As yet, legislation has generally not allowed or considered the use of human excreta as fertiliser, but practices are slowly changing along with attitudes. Institutions do not change easily but can do so while attitudes, policies and practices all start adopting new ways of operating.

It is possible that in the future ecological sanitation will indeed be accepted as a feasible option along with other sanitation methods. This is supported also by the increasing need for sustainable practices in societies. However, in more daunting futures the lack of closed cycles will lead to shortages in resources as well as the lack of wellbeing in communities without access to sanitation. Thus, the research of sustainable sanitation solution is significant and necessary – also in the future.

Keywords: Ecological sanitation, closed cycle, World Polity Theory, neo-institutionalism, futures research, Delphi method, sustainability

TIIVISTELMÄ

O'Neill, Mia

Ekologinen sanitaatio – looginen valinta? Sanitaatioinstituution kehitys maailmanyhteiskunnassa

Tampere: Tampereen teknillinen yliopisto, 2015

Kestävyys, joka tässä käsittää ekologisen, taloudellisen sekä sosio-kulttuurisen näkökulman, ajaa nykymaailmassa useita poliittisia ja hallinnollisia päätöksiä. Enää ei riitä, että seurataan vanhoja käytäntöjä tai luotetaan tulosennustuksiin – on välttämätöntä tarkastella koko yhteiskunnan ja luonnon tarpeita suurempina kokonaisuuksina. Kestävyys on avainsana myös sanitaation osalta; ekologinen sanitaatio tai lyhyemmin ecosan merkitsee kestäviä ihmisjätteen käsittelyn käytäntöjä.

Vuonna 2014 maailmassa on ilman sanitaatiota yhä noin 2,5 miljardia, joista 1,1 miljardia tekevät tarpeensa avoimeen maastoon. Sanitaation puute on usein – mutta ei välttämättä – yhteydessä puhtaan juomaveden puutteeseen ja puutteelliseen hygieniaan. Kehnoa jäteveden puhdistusta harjoitetaan kuitenkin myös kehittyneemmissä maissa sekä kriisitilanteissa. Luonnonkatastrofien yhteydessä vesipohjainen viemäriverkosto, jota usein pidetään normina, ei suojaa patogeenien leviämiseltä ja tartunnoilta. Ekologinen sanitaatio tähtää ravinteiden suljettuun kiertoon ja veden säästöön; kuivakäymälät, kompostointi ja virtsan erottelu auttavat palauttamaan ravinteet takaisin maaperään.

On välttämätöntä tarkastella vaihtoehtoja nykyiselle käymäläinstituutiolle, jonka mukaan vesivessa on tavoiteltava normi. Tämä tutkimus tutkii ekologisen sanitaation mahdollisuuksia laajemmassa kontekstissa. Tutkimuksessa määritellään ecosanin monipuoliset ulottuvuudet, kuten vesi- ja ympäristövaikutukset, terveys, kulttuuri, koulutus, maanviljely, liiketoiminta ja teknologia. Asiantuntijahaastattelujen ja tapaustutkimusten avulla pureudutaan ekologisen sanitaation nykyiseen tilaan ja siihen, kuinka se näyttäytyy lain edessä. Tapaustutkimukset tehtiin Suomessa, Sambiassa, Etiopiassa ja Uudessa Seelannissa. Teknologian käsite kattaa tässä tutkimuksessa laitteiden ja prosessien lisäksi laajemmin myös tietotaidon ja sosio-ekonomiset järjestelmät, kuten lainsäädännön, kulttuurin ja käytännöt.

Aineiston analyysin ohella tehtiin asiantuntijoille kaksivaiheinen Delfoi-kysely ($n_1=44$, $n_2=22$), minkä avulla hahmotettiin potentiaalisia tulevaisuuskuvia ja haluttuja tuloksia tulevaisuuden tutkimuksen ja toimintaympäristön muutosten tarkastelun kautta. Käymäläinstituution mahdollista muutosta arvioidaan maailmanyhteiskunnan teorian valossa – ymmärtämällä, että globaalit normit pätevät kaikkialla ja muutos lopulta

alkaa yleisemmin järjestötoimijoista ja alan ammattilaisista kuin poliittisista päätöksentekijöistä.

Laadullisen tutkimusaineiston analyysin avulla kartoitettiin potentiaalisia tulevaisuudenkuvia ja tuloksia tulevaisuudentutkimuksen ja *environmental scanning* -menetelmän avulla. Nykyisen vesikäymäläinstituution muuttamisen haasteita peilattiin maailmanyhteiskunnan teorian avulla muuhun normistoon – globaalit normit ovat läsnä kaikkialla ja muutos lähtee usein enemmän kansalaisyhteiskunnan toimijoista kuin poliittisesta päätöksenteosta.

Tutkimus tuo lisänäkemystä verrattain tutkimattomaan ja tuntemattomaan aiheeseen. Ekologisen sanitaation tarkastelu monitieteisestä näkökulmasta mahdollistaa suljetun kierron mahdollisuuksien määrittelyn niin sosiaalisesta, taloudellista kuin ekologisesta näkökulmasta. Useista arvokkaista tutkimuksista huolimatta sanitaatio-ongelmat, jotka koskettavat 2,5 miljardia ihmistä, eivät tule tarkastelluksi tieteellisessä kirjallisuudessa kovin usein. Konkreettisia tuloksia asian muuttamiseksi vaaditaan.

Tämän tutkimuksen tulokset osoittavat, että ekologista sanitaatiota tulee tarkastella monitieteisestä näkökulmasta, jotta saatavilla olevien kestävien ratkaisujen vaikutukset eri sektoreille ymmärrettäisiin. Johtopäätöksenä voidaan todeta, että perinteiset vesipohjaisen sanitaation normit muuttuvat hitaasti, mutta rajalliset fosforivarat ja infrastruktuurin rapautuminen painostavat etsimään vaihtoehtoisia ratkaisuja ja niiden käyttöönottoa. Toistaiseksi lainsäädäntö ei yleisesti ottaen salli tai edes huomioi ihmisperäisen lannoitteen käyttöä, mutta käytännöt muuttuvat hiljakseen asenteiden, politiikan sekä käytäntöjen muutoksen myötä.

On mahdollista, että tulevaisuudessa ekologinen sanitaatio on todella entistä varteenotettavampi vaihtoehto muiden sanitaatoratkaisujen ohella. Synkemmät tulevaisuuskuvat avoimine ravinnekiertoineen johtavat luonnonvarojen loppumiseen ja vähentävät hyvinvointia etenkin yhteisöissä, joissa kunnollisia sanitaatoratkaisuja ei ole käytettävissä. Tämän vuoksi kestävien ja ekologisten sanitaatoratkaisujen tutkiminen on tärkeää ja välttämätöntä – myös tulevaisuudessa.

Avainsanat: Ekologinen sanitaatio, suljettu kierto, maailmanyhteiskunnan teoria, uusinstitutionismi, tulevaisuudentutkimus, Delfoi-menetelmä, kestävyys

Foreword

I have always wanted to make a difference, to work on something that actually matters. As if by accident I started to learn more about toilets. First, I found out that a third of the world's population have no access to sanitation. Then, I learned that sanitation is not just a matter of toilets, but it is linked to public health and wellbeing, to clean environment and eutrophication, cultural issues, agriculture and food security, clean water and so on. Sanitation is linked to everything, and still it seems to be less than popular topic for people to discuss, let alone do something about it. It was then that I found my new passion: ecological sanitation.

This dissertation is a product of several years of work on sustainable sanitation, based on ideas given by more experienced researchers and experts on ecological sanitation. The work was supported by my position of trust at Global Dry Toilet Association of Finland – a time consuming “hobby” which I thoroughly enjoy. Through the association I have met dozens of people who work on sustainable sanitation, I have been involved in projects and organised conferences. In this dissertation, my goal has been to shed more light to the current and future challenges of ecological sanitation – to find out what people in different parts of the world actually think about it.

This research – done outside university while working elsewhere full time – has been funded mostly by Maa- ja vesiteknikan tuki ry, which I am grateful of. Also VALUE Doctoral School as well as Konkordialiitto have played an important part especially concerning field work and presenting results in international events. I would also like to thank the City of Tampere Science Fund for supporting the printing of this dissertation.

The CADWES research group at the Tampere University of Technology has supported especially the methodological views, not to mention the not-always-so-helpful-but-equally-important peer support from the fellow PhD students. Valuable insight has also come from Prof. Pertti Alasuutari, Prof. Tuula Tuhkanen, Prof. Eeva Furman, Dr. Harri Mattila, Dr Jarmo Hukka, as well as many other experts I fail to

name here. John Shepherd deserves to be commended for his meticulous and incredibly speedy proof reading. My humblest gratitude goes to the reviewers, Prof. Naoyuki Funamizu, Prof. Pertti Alasuutari, Prof. Juha Kämäri and Dr. Pasi Rikkinen for their excellent remarks, which helped me to improve my work. Special thanks also to the opponents, Prof. Alasuutari and Dr. Blanca Jiménez.

Extra special thanks must go to the tireless crew at Global Dry Toilet Association of Finland, who I work with (but not as much as I'd like to) to raise awareness on the importance of sustainable sanitation. Especially, thank you Karoliina for reading and commenting my papers, listening to my frustration, for being my test audience and never getting tired of learning something new about toilets and shit.

An important role has been played by Adjunct Prof. Tapio Katko and Dr Pekka Pietilä for supervising my work and getting me into it in the first place. I would not be here without you – not sure whether I should thank you for it or curse you instead (we'll laugh about this later, I'm sure). Still, the support has been continuous and you deserve my warmest thanks.

Thank you everyone who has listened to me moaning about this research, its importance, the challenges, the wasted hours and frustrations with deadlines, conclusions, ideas and whatnots. Never again do I want to go through this – and yet I already have the next research topic in mind. Just try and stop me.

And finally, I must acknowledge my family, who have been there for me through thick and thin. Thank you Mum, Dad and Shannon – I don't say it often enough. Mau.

*Once upon a midnight dreary, while I pondered, weak and weary,
Over many a quaint and curious volume of forgotten lore—
While I nodded, nearly napping, suddenly there came a tapping,
As of some one gently rapping, rapping at my chamber door.
"Tis some visitor," I muttered, "tapping at my chamber door—
Only this and nothing more."*

At home in Cape Genuine, finally on 6 September 2014 – anxious about the future

Mia O'Neill

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List of Abbreviations

BOD	Biological Oxygen Demand
CLTS	Community Led Total Sanitation
ECZ	Environmental Council of Zambia
FAR	Field anomaly relaxation
IGO	Intergovernmental organisation
(I)NGO	(International) Non-Governmental Organisation
LWSC	Lusaka Water and Sewage Company
MDG	Millennium Development Goal
MEWD	Ministry of Energy and Water Development
MLGH	Ministry of Local Government and Housing
MOH	Ministry of Health
MTENR	Ministry of Tourism, Environment and Natural Resources
NDP	National Development Plan
NWASCO	National Water and Sanitation Council
NZWWA	New Zealand Water & Wastes Association
ODF	Open Defecation Free
SDG	Sustainable Development Goal
UDDT	Urine Diverting Dry Toilet
VIP	Ventilated Improved Pit
WASH	Water, Sanitation & Hygiene
WHO	World Health Organization
WPT	World Polity Theory
WREMO	Wellington Region Emergency Management Office

The spot on earth he most had come to crave
Was not the grass plot by his parents' grave

Or any whore's bed or confession stool
Or snowy bosom, soft and warm and full.

Orge said to me: His best retreat
On earth had always been the toilet seat.

For there a man can sit, content to know
That stars are overhead, and dung below.

A lovely place it is where even on
His wedding night a man can be alone.

A humble place where you humbly know
You're only human, so you may as well let go.

A place of wisdom, where you clear the way
For the drink and victuals of the coming day.

A place where by exerting gentle pressure
A man can benefit while reaping pleasure.

You find out what you are in these dank pits
A man who feeds his face and meanwhile—sits.

Bertolt Brecht: Baal, Act One, Scene Three.

1. Introduction

Traditionally, various sectors of society, industry and environment have been considered as separate entities, such as construction, agriculture, education, and so forth. These sectors have their own tasks, specifications, goals and experts. But this categorisation is artificial; most aspects of human life and the entire planet are bound together in more ways than one. Even though it is sometimes necessary to concentrate on details and specific targets, it is also important to remember the links between the various components of society and the environment.

This dissertation has been written to bring some of the sectors together and to place emphasis on a matter which is often not so popular in public discourse. *This dissertation is about sanitation and how to tackle it in a sustainable manner.* At the same time, it will include aspects in various other sectors important in human society as well as from the environmental point of view, as no matter can be discussed sustainably without taking into account its multidisciplinary nature.

1.1 Background and motivation

Ecological sanitation – abbreviated as ecosan – is a concept originally developed to achieve the Millennium Development Goals in the sanitation sector (Winblad & Simpson-Hébert 2004). Ecosan does not favour any particular sanitation technology but concentrates on the principles which human waste management should follow. The basic idea of ecosan includes improvement of the quality of life at household level, good governance principles, holistic and integrated waste and water supply management and respect for the environment. (International Hydrological Programme 2006.) The main principles of ecosan involve the proper treatment of wastewater and nutrient recycling, returning the nutrients back to nature and achieving a balance between community development and the environment. In this dissertation, the term ecosan covers only the composition of human faeces and

separation of urine for fertiliser purposes, and thus refers to the use of dry toilets with separation facilities.

Ecological sanitation, or sustainable sanitation as it can be referred to as well, aims at a closed cycle. Current wastewater treatment is based on an open cycle: crops are grown, food is eaten, defecated, transported by water to be treated (this step is not always taken) and (cleaned) wastewater is released to rivers, lakes and seas. Meanwhile, the nutrients required to grow crops are diminishing from the soil and have to be supported by adding chemical fertiliser manufactured from minerals such as phosphate. This means that the nutrients enter the cycle from one end and exit the other, instead of circulating within the same cycle. Sustainable sanitation aims at a closed cycle instead of the current open one, where nutrients are not restored back to the soil.

In this research, ecological sanitation is narrowed down to its strictest definition. Ecological sanitation in the broadest terms is about preventing pollution, sanitising excreta and using safe products in agriculture (Winblad & Simpson-Hébert 2004). However, when examined further, sustainable sanitation (i.e. ecosan) includes also sustainable recovery and the reuse of human excreta (either by separating, diverting or combining) (SIDA 1998), and optimises the management of nutrients and water resources (Langergraber & Muellegger 2005). Some even specify that ecological sanitation includes urine diversion (Smet & Sugden 2006) and closed or renewable energy cycle (WaterAid 2011a). Here, ecological sanitation refers to water-conserving sanitation methods and therefore excludes centralised wastewater treatment plants, although nutrient recycling and energy efficiency have been established on that level as well.

However, it is necessary to bear in mind that sustainable sanitation is not only about the closed cycle. It affects much more than can at first be realised. Using clean water as a transport medium for excreta is extremely wasteful, especially in dry areas of our planet. Untreated wastewater spreads disease such as diarrhoea, which can kill up to 2 million people annually, most of whom are children under 5 years of age (WHO 2012). In addition the nutrients in wastewater cause eutrophication of water bodies instead of fertilising the soil. High infant mortality leads to people having more children, leading (unlike one might assume) to population growth. Sick people cannot work, making the economy weaker. Insufficient sanitation at schools weakens the possibilities of girls' education, especially once they have reached

puberty – uneducated women are more likely to have more children, again contributing to uncontrolled population growth. (UNESCO 2000).

Meanwhile, agriculture must produce more and more food for the growing population, while the natural nutrients of the soil are diminishing. Minerals are being mined for the manufacturing of chemical fertiliser, yet phosphorus, a vital nutrient, seems to be lacking in soils and instead is causing eutrophication in lakes and seas. As the price of fertiliser grows, so does the price of food, which can lead to food shortages and even starvation. (van Vurren *et al.* 2010.)

Eventually, everything seems to be linked to everything else, and this cycle of events, starting from sanitation, includes every human being on the planet. Imagine yourself living without a proper toilet, as 2.5 billion people today (WHO 2012). As many as 1.1 billion people, who have no toilet *at all*, practice open defecation. It all comes down to worthwhile human life, a chance to live in a clean and healthy environment with affordable food, education, clean water and safety – with dignity. (WHO/UNICEF 2012a.)

Sustainability, as described first in the Brundtland Commission report (1987), includes economic, social, cultural and environmental aspects. Indeed, it is challenging to reach a sustainable solution for anything without addressing all these aspects. This is the case also with sanitation, where there are so many variables in the equation. Unfortunately, sanitation is often considered a difficult topic to handle, a taboo even, and it would require significant changes in people's attitudes, policies and legislation – in a word, cooperation between the various sectors – to allow sanitation practice to develop in a sustainable manner.

Even though ecosan is seen by many as a solution for the poor in developing countries, there is no reason why it should be disregarded in Western countries, either. In fact, given the facts of expendable phosphorous resources in the world and the advanced technology available in industrialised countries, they should be more than interested in developing ecosan solutions. Dry toilets are the oldest type of latrine next to pit latrines. However, in a few short decades the water closet and drainage replaced the old fashioned dry toilet in cities, and soon the rural areas followed suit. Meanwhile, synthetic fertilisers replaced manure on the fields, and legislation was quickly updated. Today, the legislature in many states does not consider ecological sanitation a feasible option for fertiliser use – and in sanitation it is only a secondary option after waterborne lavatories. *Even though researchers*

have studied the science and acceptability behind ecological sanitation and nutrient recycling (e.g. Brands 2014), practical solutions are still lacking – often due to restrictions in legislation. The role of legislation has not been studied in detail, so this research aims at solving what issues are limiting ecological sanitation despite the best efforts.

1.2 The research questions

In order to shed more light onto sustainable sanitation, this dissertation will discuss the challenge at hand. First, the overall situation of sanitation is described and the main topics researched today are introduced in the chapter on literature review – including the latest findings and upcoming challenges. In the following chapters, the core dilemma of attitudes and legislation is discussed in more detail with the help of case studies from all over the world. *The aim of this dissertation is to study the bottlenecks of ecological sanitation practices and listing the challenges which still remain to be solved in order to reach sustainability in sanitation. But most importantly, this dissertation will introduce the research indicating the constraints which prevent any further measures being taken in sustainable sanitation.*

The field of sustainable sanitation is vast and many have taken up the challenge of trying to improve the world sanitation situation. Subjects involving technology, agricultural reuse, public health, gender and cultural issues have been studied extensively, as can be seen from the collection in Chapter 4. However, the legislative and sociological research has not been as extensive. This is why this dissertation concentrates on the following research questions:

- i. *How – if at all – is ecological sanitation made possible by legislation and policies in different countries?*
- ii. *What issues have impact on the implementation of ecological sanitation?*
- iii. *How could ecological sanitation become a more feasible option as a mainstream sanitation solution?*
- iv. *What types of futures scenarios can be found for ecological sanitation?*

With the help of case studies, expert interviews and literature analysis, as well as in the light of previous research, this dissertation aims at creating an overall picture of the current status and potential of sustainable sanitation, concentrating on the political and sociological aspects of attitudes, practices and policies.

1.3 Philosophy of the research

The common division between the philosophies of science is between positivism and hermeneutic philosophy (Pitkäranta 2010; Anttila 1998; Eskola & Suoranta 1998; Varto 2005). Positivism searches for regularity and is often linked with quantitative research methods. This research, being qualitative in nature, employs a hermeneutic approach, which could also be referred to as social constructivism. (Eskola 1998; Pitkäranta 2010.) This means that information is formed in social interaction between people. A hermeneutic approach to science requires understanding between the researcher and the target to be researched: understanding the processes, the connections and the reasons behind the studied phenomena is necessary. The qualitative empirical data is studied based on the interpretation of the researcher – the hermeneutical approach emphasises understanding and interpretation of the data. (Pitkäranta 2010; Varto 2005.) This is often portrayed in the hermeneutical circle or rather a spiral, where studying the target changes the interpretation over the course of the research (Figure 1). The role of values is emphasised, unlike in positivism, where value based discussion is often ruled out. The phenomena in question are linked to other aspects of society and the development of other phenomena.

Even though the hermeneutic research approach requires continuous dialogue between various sources of data and interpretation, it is not to be separated fully from quantitative research: methods are not used solely in one or the other of the approaches. (Pitkäranta 2010; Eskola & Suoranta 1998.) There is no need to make an artificial division between qualitative and quantitative research.



Figure 1: Hermeneutic circle. In Rodwell (1998).

Here, the research discusses the development of a particular sanitation practice and its practices, its domestication in various cultures and the implementation and support of the practice. Analysis lies in human values, institutional development and analysis of futures scenarios.

Even though this research cannot be classified as action research (Pitkäranta 2010; Varto 2005), it does include some aspects of such study. The author has been the Chairperson of the Global Dry Toilet Association since 2010. Before this, she has been active in the organising of the International Dry Toilet Conference ¹in 2009, 2012 and 2015 (forthcoming), while she also participated in the conference in 2006. The Dry Toilet Conference, being unique of a kind focusing on solving the world's sanitation challenge in a sustainable manner, gathers experts from all corners of the world to discuss ecological sanitation, nutrient recycling and practical applications in academic surroundings. Papers, peer reviewed by an esteemed scientific committee, bring forth the latest research of several disciplines as well as experience from the field; they play an important part of the references used in this research. The author's work in the NGO, which could be compared to an expert organisation, has allowed her to participate in the organising of several seminars

¹ Organised every 3 years by Global Dry Toilet Association of Finland, the conference discusses the various aspects of ecological sanitation and has gathered up to 160 experts from nearly 40 different countries across the globe to discuss the matters. The papers (not merely the abstracts) are peer reviewed by the scientific committee to ensure quality and scientific standards.

trainings, events, the publishing of articles and statements, and giving speeches in various events. This background brings much to the research at hand, and directs it even more towards policy oriented research.

1.4 Structure of the dissertation

This dissertation is structured as follows. First, as the introductory chapter has laid down the background and motives for the research, as well as the research questions, so the second and third chapters describe the theoretical framework and methodology. The theoretical framework includes views on development and it relies heavily on neo-institutionalism and World Polity Theory in order to understand the state of ecological sanitation. Furthermore, the theory and methods of futures research are used in order to gain information on how ecological sanitation could be made a more feasible option in the future.

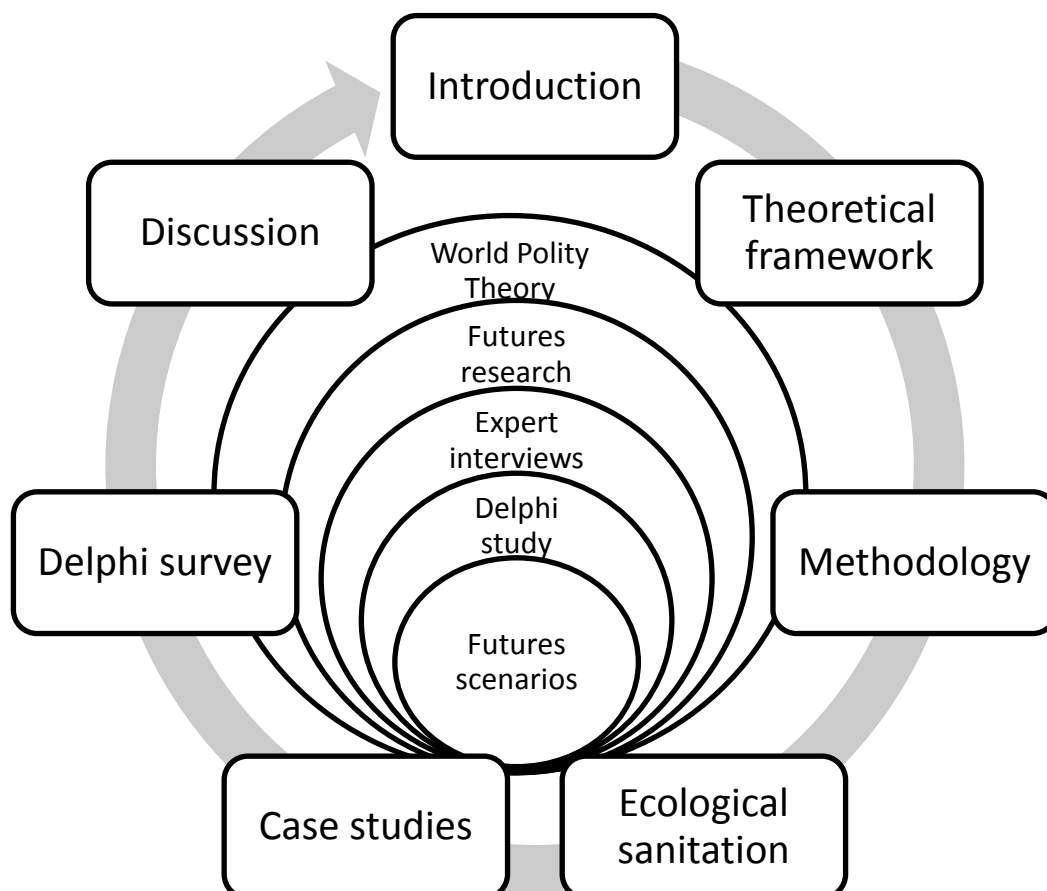


Figure 2: Structure of the thesis.

In Chapter 4, the overall environment of ecological sanitation is introduced, and with the help of the PESTEL framework (Thompson 2002) and a mind mapping method a picture of all effects influencing the topic in question is discussed. The chapter also looks into other research conducted on ecological sanitation, mentioning some – but not all – relevant studies and authors of the field.

The four case studies are described in Chapter 5; Finland, Zambia, Ethiopia and New Zealand (as studied in a chronological order) are approached from different viewpoints to obtain an overview of ecological sanitation in different countries and environments. In addition, a general glimpse is also given of the rest of the world for a more in-depth view of ecosan. The case studies act as examples of how ecological sanitation is viewed in different environments and circumstances. They depict the role of legislation in each country, and how the development could continue towards a more sustainable direction.

In Chapter 6, the Delphi survey conducted with Finnish experts on the status of ecological sanitation is presented. The analysis of the survey as well as the cases continues in Chapter 7, where the theoretical framework is bound together with the research results. The Delphi survey adds to the case studies by more wide ranging views of Finnish experts on ecological sanitation, and especially supports the analysis regarding research question number *iv* on the potential futures scenarios. In Chapter 8, the discussion takes place on the analysed data, and finally Chapter 9 ends the work with conclusions.

Pecunia non olet.

-Emperor Vespasian (69-79)

2. Theoretical framework

The “powder room”, “rest room”, and many even more imaginative euphemisms – indicate that going to the toilet has always been a part of human life. The conditions of this daily act have changed over the millennia, but the need has always been there. The cultural views of this everyday chore have been similar across the world: talking about toilets is still often considered a taboo. Also toilet and wastewater treatment technologies have developed and spread around the world, as well as knowledge of the larger picture presented by our waste. From bushes to pits, and onwards to indoor water closets and space age rear wiping equipment – *Homo sapiens* has tried to make a necessity into a luxury item, and partly succeeded.

As can be noted when examining the development of sanitation, it is not so different from any other type of development. In fact, it can be seen that sanitation development forms a circle, where no outright innovations are being created. This can be also seen as a characteristic of development in general – it is difficult to develop without knowledge of the past and to think of something entirely new.

In this chapter, the theoretical framework of this study will be put together. First, aspects of development will be examined within the multifaceted framework of PESTEL, followed by the development of sanitation as an institution and the spread of the flush toilet as a norm and standard in the light of the World Polity Theory. The theoretical framework builds a foundation for the research of the toilet institution as well as the future developments of ecological sanitation.

2.1 The cycle of development

As was already pointed out, several issues affect the progress of development. There is the matter of hygiene. It was slowly understood that human excreta can cause epidemics and ruin drinking water. It was cleaner to have one specific place to

do one's business, and later it was discovered that water is a great utility for transporting the waste to some more distant location than one's backyard.

Of course, it is difficult to make people do anything unless it is a) profitable, b) beneficial in some other way, or c) made compulsory by law. As the amount of information increases, so the legislation must be updated. (Perez 2009.) Sanitation legislation developed further and started to require proper latrines, wastewater treatment and other types of measures from the people and the municipality (e.g. Nygård 2004). However, even legislation does not change by itself and resistance towards change exists also among the decision makers. Political debate as well as questioning of practices and decisions can still be seen today when discussing sanitation methods and requirements. (Gajurel & Wendland 2007.)

Everything started, of course, with the idea of a toilet, more specifically a water closet. The technology developed to meet the standards and wishes of the people and the state. Waterborne sanitation was already enjoyed by the ancient Romans (Vuorinen 2007 *et al.*). It is unrealistic to have a law that cannot be technologically implemented, so regulations must develop hand in hand with technological development. Here, technology does not stand for merely technological artefacts as is classically understood, but as Leppälä (1998) defines it, more widely and more appropriately, to cover also procedures and knowledge *to be applied to* technological artefacts (Antila *et al.* 2013).

The most common usage for the word *technology* is to describe *manufactured objects*. To engineers, the term would be hardware; to an anthropologist, an artefact – indicating the clear distinction between disciplines and their choice of vocabulary. The second most common usage for the word describes the manufacturing *processes*. Thirdly, technology can refer to *knowhow*, *methodology* or *sociotechnical system*, indicating to the information and skills required to perform a task. However, there is a fourth usage that has no common name but what is called by Stephen J Kline as *sociotechnical system of use*. For example, the technology of automobile industry requires, apart from hardware and knowhow, also a road infrastructure and network of gas stations, rules of the road, laws for ownership and operation, all resulting to the human capacity required to use the automobile for its purpose – transport. (Kline 1985.) It is necessary to understand that technology is not limited to hardware and knowhow, but it incorporates the entire realm where technological artefacts are used – or are planned to be used. Innovations often

require a change in norms, laws, rules and even values before new applications can be taken into use. (Mesthene 1967.)

Also Hughes (2004) points out that technology is not limited to technological practices often seen as *engineering*, but ought to include also the processes that bring technology into being, namely invention and human ingenuity (Hughes 2004). Without human contribution, technology does not develop – and human contribution requires need, innovation and acceptance in order to allow development and change to take place.

Change is continuous in natural systems and only people living outside nature can consider their lives untouched by it. However, humans interact with nature whether they want to or not. Human excreta in the wrong place causes eutrophication in water bodies and can spread disease, while in the right place it enriches the soil with nutrients. This fact cannot be ignored, which is why it is handled in some pieces of legislation – often after a long political debate.

As mentioned before, people will not do anything unless they have an incentive or are forced to do so. The same goes for private households as well as at the state level: this phenomenon is known as organisational inertia, which happens everywhere, but is often pushed aside if money and competition are involved. (Perez 2009.) There is no need to build a functioning sewage network unless it is profitable in some way: perhaps it will reduce health care and water purification costs. Perhaps it is a pretentious thing to do. Perhaps a toilet should be acquired because the neighbour has one. And so on. But these issues are also affected by or affect legislation and the political side of things – and as a crude generalisation it can be said that technology does not develop without a need. Thus, we have achieved a tight loop of development, which can also be referred to by the PESTEL framework (see Figure 3).

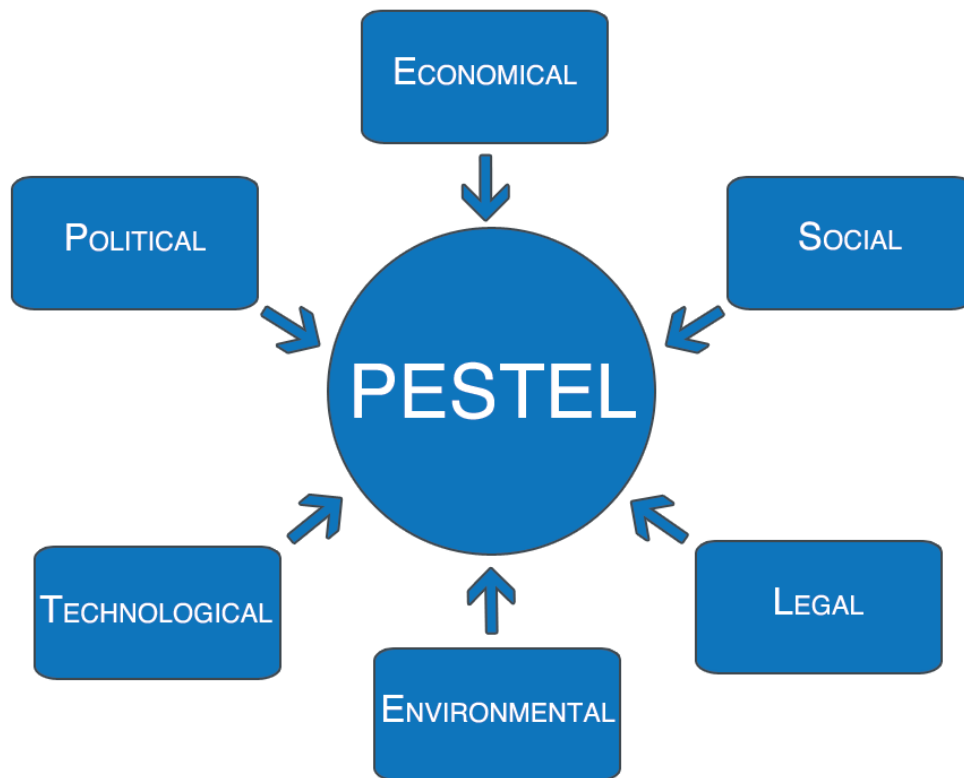


Figure 3: PESTEL model. (Professional Academy 2014.)

In the PESTEL framework, Political, Economic, Social, Technological, Ecological and Legal issues affect one another and create a framework for a phenomenon to occur in, and as described in Figure 3, it can be seen as a never-ending cycle (Thompson 2002). All these aspects affect people's attitudes, which again affect practices, which then affect and are affected by development. In short, we have a complex cycle of issues influencing development, and we have the history of sanitation which appears to be repeating itself with some fine tuning. The PESTEL model is used here to identify the key individual aspects that influence the change in world society. These elements are examined as a whole by World Polity Theory, but are also dissected to understand the factors affecting the change. The various viewpoints identified in the PESTEL framework support the analysis of the futures scenarios as well as the overall picture painted by the World Polity Theory. The PESTEL matrix used in Chapter 7.3, Table 6 enables further the development of futures scenarios, and the method is often used also in futures research as well as in administrative studies (see e.g. Hietanen 2009; Hietanen & Pihlavisto 2009; Järvinen *et al.* 2011).

2.2 Development of the sanitation institution

Sanitation has been used merely as a tool when analysing the never-ending connections and cycles that define our society and even the world. Development is similar, whether we observe the technological development of telephones, from jungle drums to microscopic spy equipment, or sanitation, from bushes to elaborate backside-washing-apparatuses and back to ecological dry toilets. Even though development may be cyclical and knowledge of history can be helpful when trying to foresee the next trends, it is important to remember that nothing is ever the same. The dry toilets available in shops today are certainly a far cry from the ancient long drop – only the practice of returning nutrients back to the soil has remained the same. This is because technology develops together with social values and needs, but at the same time ecological values (and, indeed, needs) may overcome the seemingly luxurious comfort of water-based toilets (as long as the system is functional). Political decisions and economic incentives also have an effect on practices and eventually attitudes – and soon we notice that the values of the future are those of the past.

But what is the use of understanding the complexity and yet the uniformity of the PESTEL framework concretely? When planning, designing or judging methods and practices, old and new, it is important to have an open mind. It is important to see the overall view and to be able to anticipate at least some of the unpredictability that is certainly waiting around the corner. It is also useful in manipulating the masses and getting your own way in almost anything, but that should be irrelevant. Ultimately, it is possible to simply sit back and enjoy and let the development take its turn, and in many cases it is impossible to even affect the outcome with uncontrollable forces and drivers affecting the form of society, values, attitudes, and so on. But when considering innovations, the must-have-products and noticing one's own values changing in the process, it is good to stop and wonder for a while: which of these values are mine, and which are affected by society, the available technology, the legislation, tax incentives, and so on. (O'Connell 2014.)

Finally, to tie it all back in to sanitation, it is necessary to ponder history, current development and the potential future that is desired. It may be necessary to see beyond the development of society and technology, and look at oneself – because ultimately social development and change in attitudes starts from the individual

(who is affected by the masses; yes, the cycle starts again). Will we see a more ecological sanitation age, or alternatively the development of water treatment facilities and the fertiliser industry? How will the sanitation institution develop – and will it develop the same way everywhere?

2.2.1 The toilet as an institution

Initially, the thought of toilet as an institution can appear somewhat fuzzy. Institution as a concept can mean structures of thought, rules or routines, but also more formal laws and standards, or even shared norms or values. Here, the concept of institutionalism will be approached as a theoretical framework, helping the understanding of sanitation and its development, as well as its standing in world society.

Especially John W. Meyer and Ronald L. Jepperson have approached the concept of institutionalism as an application to understand the social actors in the formation of “world culture for social organisation”. The question is of the rationalisation of social life, the social world becoming more systematic and standardised. (Jepperson 2001.) The emphasis on what is called sociological neo-institutionalism is that everything rational is in fact socially constructed – and therefore also alterable. The concept of *institution* refers to structures and patterns which form a relatively stable system of knowledge, or institutional matrices. Institutions provide the models of thought for the actors to follow – and take for granted.

Institutions carry a variety of definitions based on the discipline studying them. Here, the sociological aspect of institutions is embraced. Instead of limiting the definition of *institution* to human designed products, frameworks of rules and arrangements and recognised practices, the neo-institutionalism in sociology approaches the term *institution* as norms, cognitive frames, and meaning systems guiding human action, as well as the cultural scripts serving symbolic and ceremonial purposes rather than mere utilitarian ones. (Schmidt 2005). In the light of sociology, institutions are everywhere, as “sociologists view behaviours as potentially institutionalizable over a wide territorial range”. (DiMaggio & Powell 1991.)

In this branch of institutionalism, it is considered that individuals do not choose freely among institutions, customs, social norms or legal procedures – instead of basing the theory on individual choices it is based on expectations which are taken for granted through socialisation, education and learning by doing. Individual choices are always linked with cultural and historical frameworks, and so-called rational choice is affected by secular rituals, myths and legitimate constraints. (DiMaggio & Powell 1991.)

According to the sociological view of neo-institutionalism, any behaviour or structures can become institutionalised. Furthermore, it is argued that those institutionalised behaviours and structures are ordinarily slower to change than those which are not. In fact, institutionalised practices are reproduced because “individuals often cannot even conceive of appropriate alternatives (or because they regard as unrealistic the alternatives they can imagine)”. (DiMaggio & Powell 1991.) Institutionalisation is, to be fair, a relative property. It is up to the examiner to decide whether to consider an object to be an institution, as whether a practice is an institution is relative to a particular context. (Jepperson 1991.)

Through the effect of expectations, institutions become standard activities that are taken for granted, i.e. there is a common social account of their existence and purpose. People may not fully comprehend an institution, but they typically have knowledge of some account of why the practice exists. Institutions are taken for granted in the sense that they are considered as functional elements and fixtures of a social environment. This is to say that institutions are socially constructed, routinely executed program or rule systems. Institutions can be cultural, i.e. not monitored by any authority, or they can be regimental, monitored and sanctioned by a “central authority”. (Jepperson 1991.)

Taking these definitions of an institution, it is rather easy to justify the institutionalisation of the toilet facility. The current institution of the Western society is the WC, a flush toilet, which you can access wherever you need to. The institution is the sitting version, trying to squat on a Western toilet seat is not the norm, and most people would discourage you in attempting it. It is also advisable to flush the toilet, clean it after you, and wash your hands once leaving the toilet. In cultures where toilet has not yet become a norm (it may be an institution in legislation and there may well be authorities regulating the sanitary facilities – but not in practice), the norm may be open defecation; in some countries where the

situation is grave enough, it is not frowned upon to go to the toilet on the street or in a river (O’Connell 2014). These institutions are old, and they have found their place in society – they base their solidity on the fact that humans need to relieve themselves and they also need to keep their environment clean. These institutions also change slowly, because in many cultures discussing sanitation is a taboo, or is at least not the favourite topic at the dinner table.

Yet, also in these cultures, where sanitation is not well developed and open defecation is practiced, the idea of a toilet (sitting or squatting – in this case it is all the same) is a desirable one. Once knowledge of sanitation and its importance spread to these open defecating communities, a latrine is soon considered an institution – and hand-washing becomes a norm. The “Western” style flush toilet becomes the main desire; any other pit or dry latrine is considered equal to poverty, sickness, discomfort and unhygienic practices. This inevitably takes us to the idea of common world culture, world polity.

2.2.2 World Polity Theory

Development can be brought on by several factors. It can be the need for improvement or the ability to innovate – or simply the desire for change. In the case of sanitation, several aspects have taken us from bushes and pit toilets to where we are today. Yet, the norms and the common cognitive models are brought on by - what? It can be argued that waterborne sanitation has become a norm because it is considered as such in industrialised countries, but there are alternatives to it.

When analysing various countries and their habits, it can be argued that countries will go through the certain stages of development. In terms of sanitation, we see the path from open defecation to bushes and pits, to ventilated improved pit latrines (VIP) and finally to flush toilets – followed by (sooner or later) a sufficient wastewater treatment process. The key observation in this development is that even though countries have different cultural customs and traditions and are in differing levels of development, they do share some aspects in their governmental structure, in their political and economic field as well as their desire for sanitation. This, argued by World Polity Theory, reflects the existence of a common global culture. (Schofer 2010; Alasuutari 2011b.)

This research examines the reasons behind the development chain of sanitation in both developing and industrialised countries. It can be noted, based on World Polity Theory (also known as World Society Theory) (Alasuutari 2011a; Beckfield 2010; Schofer *et al.* 2010), that the driving force behind any societal change can be narrowed down to IGOs and NGOs (inter-governmental organisations and non-governmental organisations) forming a “world society”, thus conveying a model on how to operate. The theory goes on to suggest that associations, affecting global norms, will eventually bring on new trends and policies, such as can be seen in several examples in global environmentalism. Through this common global culture, new practices are allowed to emerge and become normative.

Culture affects us in several ways by setting norms that “indicate proper behaviour in a given situation”. Culture provides us with scripts, which are “taken-for-granted” recipes for behaviour that we understand and usually share with people in the same or a similar culture. Culture also gives us certain cognitive models, i.e. mental frameworks that we share with people in similar cultures. According to World Polity Theory, participants in the international system share a common culture. World Polity stands for political structure, associations and culture in the global sphere. It can be found, however, that there is no strong world “state” as such; instead, there are association (IGOs, NGOs). Further, the theory argues that governments and international standards are increasingly affected by IGOs and NGOs, which are also typically run by people who believe in a common goal and are educated in Western-style tradition. Trends such as democracy, education and other widely spread ideologies and concepts can be seen as examples of this. (Beckfield 2010; Schofer 2010.)

WPT theory emphasises isomorphism, i.e. countries are becoming more and more similar to each other in terms of government and policies. By looking at legislation in different countries or how their educational system is set up, it is easy to see that even though countries might be on different levels of development, they tend to adopt similar models from other countries (usually, from ones higher on the development ladder). The key claim of World Polity Theory is that states govern on the basis of cognitive models, which come from the culture and society around them. This “world society” or “world polity” is formed by associations, IGOs, NGOs and other states. (Schofer 2010; Alasuutari 2011b.)

IGOs and NGOs also play a large part in how states are governed. They give advice and statements, spread information and convey models on economic governance, educational systems, human rights policies, environmental legislation etc. IGOs such as the World Bank, UNESCO, Amnesty International and Greenpeace play a key role in sustaining a common culture around the world by establishing norms which are adopted by governments. The key here is that the role of IGOs is purely based on affecting the norms and behaviour of states as well as the people in them. The IGOs have no power as such, and not all countries follow the common norms, but – over time – these norms can affect behaviour drastically. The success of the environmental movement can be considered as an example of WPT in practice. (Beckfield 2010; Schofer 2010.)

World Polity Theory does not give direct answers as to how global trends find their way to a particular country, but the findings are based on statistical comparison of variables that might affect the development (Alasuutari 2011a). It is possible to identify key issues, however, by concentrating on case studies: where do the said trends come from, which actors are promoting them, who moulds the new practices suitable for the particular society, and how?

Concentrating on the framework of domestication, as Alasuutari suggests (2011a), is beneficial especially in qualitative research. Case studies from Finland, Ethiopia and Zambia (O'Neill 2011) are used as examples to determine the status of ecological sanitation and its history - in order to predict the future trends in the field.

2.2.3 Development of sanitation and WPT

In order to understand the development of ecosan, it is necessary to review the current development of sanitation. Already at a very early stage of cultural evolution of humans, revulsion towards foul-smelling, tasting and looking water was an established perspective, and people tended to avoid contaminated water sources. However, as people adopted an agrarian way of life and started to build permanent settlements, the health risk of contaminated water grew considerably. (Vuorinen *et al.* 2007.)

Still today urban settlements face a problem with their wastewaters. Up to 10 000 people, mostly children and elderly, die daily due to various diarrhoeal diseases

which could have been prevented by adequate sanitation. (WHO 2012.) The problems have not changed in thousands of years, nor have the realities: proper sanitation facilities decrease the risk of public health and environmental problems.

Naturally, people in many parts of the world enjoy the convenience of a water closet. Since the early 20th century, after long debate, the water closet has been a generally accepted cultural necessity in Western countries (Drangert 1998; Vuorinen *et al.* 2007) - and today it has become the general standard across the globe. The water closet is considered to be more hygienic and safer than other latrines despite the fact that the wastewater can end up practically anywhere.

The idea of water and cleanliness go hand in hand, and the idea of water as a medium for bacteria is not as widely acknowledged. Yet, what started as a luxury for the rich has become a generally desired outcome for all - the white porcelain seat that transports the waste away in a single flush has a sense of beauty, purity, and wealth. (Vuorinen 2007; Jenkins & Curtis 2005).

The somewhat recent success of the water closet helps us understand what issues are meaningful in sanitation. Cleanliness, including health and environmental aspects, is a clear variable for the development of sanitation. The main reason behind the first toilets and sewage systems was to ensure clean water for drinking and washing, and to remove the contaminating waste (Vuorinen *et al.* 2007). Another aspect is financial: the water closet was - and still is - a symbol of wealth or something that determines the social and economic status of a household (WECF 2006; Anderson *et al.* 2008; O'Neill 2012). From a societal point of view, a clean city is also more productive; an individual considers a toilet an investment for health - and for social appearances. Therefore, the third aspect is social value. It turns out that the three main points which influence the development of sanitation methods are the three pillars of sustainability mentioned in the first paragraph of this paper: environmental, economic and social.

In the light of World Polity Theory it can then be assumed that the domestication process of the water closet has been successful, despite its shortcomings. As new technology became available, old practices started to change and people's attitudes towards the water closet became more positive. Eventually, the authorities started to promote waterborne sanitation and it found its way into legislation – causing severe epidemics in the process before wastewater treatment was organized (and even after that). (Drangert 1998; Vuorinen 2007.) Today, waterborne sewage systems are a

norm in most countries (see e.g. Water Services Act 119/2001 for Finnish practices and Water Supply and Sanitation Act for the Zambian point of view). It is necessary to note that new models are never simply adopted; only once they turn into actual practices will they finally domesticate and disappear into the old practices (Alasuutari 2009).

WPT emphasises the influence of norms and culture instead of power. This makes it still a rather new and controversial theory. Power and functional rationality are often seen as the main drivers of societal change, and the idea behind WPT does not support this claim. The theory also recognises the importance of INGOs as driving forces in social change. There are, globally, over 200 non-governmental organisations operating under the Sustainable Sanitation Alliance (SuSanA), and many smaller actors, which spread the word on sustainable sanitation, share views and new research amongst themselves and within their own networks (SuSanA 2014). The work done within the SuSanA network acts as an example of the domestication process of world models via (I)NGOs. It can be argued against World Polity Theory that colonial relations and global trends reflect US hegemony and that they are stronger causes of the current development towards the “Western” ideal of the dominant world culture. This can be the case, but in terms of sanitation the tendency to favour Western development does not explain the various other norms and developments of the global “sanitation culture”. In fact, world polity research is dominating the fields of evolution of education systems around the world, explaining the success of the environmental movement and other growing trends, such as human rights. Thus, it can be considered as a suitable theory to be taken into account when observing the development of sanitation, an institution carefully protected by cultural norms and global trends.

Without faeces (in its broadest sense) life (and humanity) would not be possible.

David Waltner-Toews:

Five things you need to know about poo

3. Methodology

This research is conducted using a variety of methods and theoretical frameworks to bind together the empirical data used in the research. Overall, the goal is to concentrate on the observations based on the empirical data gathered here; moving from empirical data towards theory, to understand the problematic nature of the data available. The research is qualitative in nature, although also quantitative methods are used to analyse the data more thoroughly.

3.1 Triangulation

A triangulation method has been used to gain insight into the research topic at hand from various points of view. In fact, multiple triangulation methods have been used, as there is a variety of data, methods, as well as theoretical frameworks in use here. In terms of methodological triangulation, several approaches have been used to collect data, including expert interviews and surveys: this is called the between-method. (Saaranen-Kauppinen & Puusniekka 2005; Taanila 2005.) Expert interviews of a multidisciplinary nature were conducted in the selected case countries: Finland, Zambia, Ethiopia and New Zealand. These supported the findings from the literature on previous research done in the field: a review of key documents is further explained in Chapter 4.

Furthermore, legislation and policy documents from the case countries were examined to confirm the views of the expert interviews. In addition, statistical data on sanitation was used, where applicable, combining the use of qualitative and quantitative methods. The multiple triangulation method was found useful as there is no consecutive data on ecological sanitation as such – one data source or method alone could not provide sufficient information required for this study (Saaranen-Kauppinen & Puusniekka 2005; Taanila 2005). The research material at hand is

analysed further in the light of futures research: the overall picture is revealed by environmental scanning.

The material was gathered in stages, starting with a review of literature and legislation in 2010, and conducting the expert interviews during 2010-2013 (see Table 1). The Delphi survey was conducted in 2013, and the survey utilised the findings gathered in earlier stages. Legislation and literature was referred to again during the interviews, as well as the Delphi. A theoretical framework was formulated around the data to enable analysis and support further analysis for the futures scenarios. Typical of qualitative research (Eskola & Suoranta 1998; Pitkäranta 2010), the dialogue between data, methods and theory continued throughout the study, contributing more in-depth insight and new viewpoints in each stage. The triangulation of various methods supported the reliability of the research by confirming the findings from several angles.

Table 1: Schedule and focus of the research process



3.2 Literature analysis

To begin the description of the current situation of ecological sanitation, the wide range of research conducted on it must be introduced. In Chapter 4, the most relevant studies on sustainable sanitation are presented from the ecological, economic and cultural viewpoints. The division is by no means complete, as a number of studies are conducted globally; the purpose is merely to give an idea of the challenges and solutions discovered by ecosan-scientists.

To be able to fully grasp the current situation from a legislative point of view and to study the cases in-depth, it was necessary to explore the legislature of the case countries. Legislation in Finland, Zambia, New Zealand and Ethiopia was studied to prepare for the interviews as well as gain insight into how legislation and policies affect attitudes in each country.

3.3 The case study method

In order to understand both the variety and similarity of environments and cultures, it is necessary to examine not only the phenomenon of ecological sanitation in general, but also have a closer look at some cases. The case study method is useful for gaining an insight into the realm of ecological sanitation in all parts of the world.

The case study method is an empirical method which analyses a certain event or action in a restricted environment by using multi-faceted information gained by various means (Yin 1987; cited in Pitkäranta 2010). The purpose is to study intensively a certain target, such as an individual, group, organisation or community. The technique is useful especially when adequate background information is required. (Pitkäranta 2010.) The qualitative case study method is excellent for understanding processes, and in this research understanding the development of the status of ecological sanitation is the key target. A case study does not include the isolation of individual actors but examines the case as a whole. (Syrjälä *et al.* 1994.) Due to the intensity of the case study method, it is recommended to describe them as thoroughly as possible.

The case study method allows the analysis of important actors, processes and communication in one entity. It produces detailed information, and is more a narrative than an actual analysis. (Pitkäranta 2010.) Thus, it is not possible to generalise findings based solely on the case study method, as they are not necessarily universally applicable. The case study method is used by many researchers to build upon theory, dispute or challenge an existing theory, or produce a new one. It is also used to explain a situation, to provide a basis for applying new solutions and to describe an object or phenomenon. (Flyvberg 2006; Soy 2007.)

In this research the case study method was used to identify the past, present and future state of ecological sanitation in each country, as described in Table 1. The case studies have differing targets: Case Finland examines both the history as well as the current state of legislation in the country. Case Zambia discusses the development of legislation and ecological sanitation in practice. Case Ethiopia concentrates more on the development of attitudes and policies, and Case New Zealand emphasises the emergence of a new practice in crisis management. Each of these cases examines details relevant to development of the status of ecological sanitation, and they act as examples of the theoretical framework in practice. They also serve as a basis for further analysis of futures research and development of a new institution in sanitation. Yet, even though the focus varied from case to case due to such different standing of each case, the background study was similar and the main goal was to determine the status of ecological sanitation in each country.

3.4 Expert interviews

The most crucial part of the case studies as well as the overall analysis was the expert interviews conducted in each case country. The goal of the interviews was to gather facts on the past, present and future(s) of the case countries. The experts represented ministries, city councils, NGOs, and research institutions, and gave their opinion on the status of ecological sanitation, how it is implemented, how the legislation handles it, if at all, and what the general trend is towards it.

In expert interviews, the topic of interest is not the interviewee but the topic in question; in fact, expert interviews serve mainly as fact-finding tools to support the research. It is necessary to have gone through the essential literature before expert

interviews are performed in order to know how to ask the right questions. It is also worth noting that “wrong” answers are possible with expert interview, as the experts are only human and can have limited knowledge on the matter. (Alastalo & Åkerman 2011.)

In order to escape the potential “wrong” answers and to confirm the experts’ opinion, the interviews were analysed and compared with documents on legislation and policies. Cross referencing between the material from the interviews and other documents makes it possible to form a full picture of the topic in question. (Alastalo & Åkerman 2011.)

Many of the interviews were carried out at the beginning of the research: interviews in Zambia (7 interviews) were conducted in 2008 and 2010, while two interviews were carried out in Ethiopia in 2011. The interviews in New Zealand (2 interviews) took place in 2012 and 2013. These interviews were open (*deep interviews*) in nature, as it was necessary to have tailor-made questions for each expert (the structure for the interviews can be found in Appendix 2). In fact, it is typical for expert interviews to be synchronised with the analysis of literature and other documents, as the expert statements support the documents, and vice versa. (Alastalo & Åkerman 2011.) Several interviewees were also contacted afterwards by email or telephone to retrieve more information.

The amount of interviews conducted in each country varied, as they were conducted over a long period of time. The Zambian case acted as an example and helped to pinpoint the most important aspects and roles; the contacts were found using the so-called snowball method. The interviews in Ethiopia and New Zealand, conducted later, allowed a more targeted method, where the key people were contacted directly. The amount of literature varied from each country, as there were significant changes regarding how ecological sanitation was mentioned in the legislation or policy documents, or if anyone had knowledge of the practice. Most experts that were contacted in New Zealand rather referred inquiries to the interviewees in question due to their lack of knowledge. Case Ethiopia was similar, and some of the planned interviews were transformed into email correspondence due to varied availability of some contacts. Nevertheless, the interviewees represented the people with knowledge of ecosan practices in the particular country, but due to the differences in the case countries, the amount of people with such knowledge varied.

As the goal of case studies is to gain more in-depth knowledge on the phenomenon in question, the cases do not give a comprehensive picture of the state of ecological sanitation or legislation regarding it, but rather indicate *how* different environments and circumstances affect the implementation of ecological sanitation.

3.5 The Delphi expert panel

In 2013, Case Finland was further examined by gathering expert opinions via the Delphi method, which is often used in futures research. A Delphi is an expert panel, where experts from different disciplines are invited to share their views on a certain topic: here, the feasibility of ecological sanitation (Rubin 2012). The expert panel was gathered in April 2013, after which two rounds of online surveys were launched in April-June 2013. In the first round, there were 44 respondents, and in the second round 22 experts took part in the survey. The panel was organised in cooperation with the active members and board of the Global Dry Toilet Association of Finland (GDTA), and given the broadness of topic in question, the questions do not apply to the research questions of this study as specifically as they could. The Delphi analysis, therefore, acts as a method of gathering data, but is not thoroughly analysed in this research due to the wide range of questions portrayed in the survey. Nevertheless, the entire survey is presented here to present the exact nature of the survey. The Delphi method is described more closely in Chapter 6.

3.6 Futures research

As one of the goals of this research is to determine the future aspects of ecological sanitation, it is necessary to examine the topic within the framework of futures research. In this section, the views on futures research are introduced, after which the methods of futures research used in this research are described. To support the previous views on institutionalism and World Polity Theory, the changes and impacts of ecological sanitation are examined with the method of environmental scanning, which studies the trends, weak signals and other aspects influencing the said phenomenon.

3.6.1 Futures research in general

Contemplating future events is not a new phenomenon, but all human communities have found the future intriguing and have attempted to predict it. Modern futures research, however, is a relatively young field of science that could be traced to the 1940s where, among other things, the term *futurology* was first cited. (Bell 1997; Masini 1993.) Modern futures research is used in many fields, including the strategic planning of governments, the military, companies, etc. Academic attempts to evaluate future events have grown more popular over the years and the original stigma of futures studies as predictions no longer apply.

There are three principles of futures research:

1. The future cannot be predicted. We can form ideas on what might happen – the study is focused on several alternative futures.
2. The future is not preconditioned to happen. We analyse potential futures, possible futures.
3. We can and do have an impact on future events with our actions and choices. Therefore, it is important to distinguish what is possible, probable and desirable. Value discourse is an important part of futures research.

(Amara 1981; Masini 1993.)

The future is studied in order to be better prepared for upcoming events, to improve human wellbeing as well as maintain the condition of the environment and the entire planet (Bell 1997). Futures research can be considered as a certain way of thinking that is labelled by multi-, trans- and interdisciplinarity, complex, normative, scientific, dynamic and participatory approach (Masini 1993). As a relatively new field of study, futures research uses methods from other disciplines where applicable and has also embraced some methods that are now considered as the main tools in futures studies, including the Delphi method, scenario techniques and environmental scanning (Aalto 2010). In this study, the methods applicable will be used for analysis, namely the Delphi method, environmental scanning and scenario analysis.

One key element in futures studies is the concept of time. Past, present and future are all bound together: the past affects the present and potential futures – and vice

versa, and without the past it is difficult to see the development of a phenomenon as a whole. The past and present are also tied to culture and the values it represents. Values themselves are important in futures studies, as values influence the analysis of what is considered a desirable or preferred future. Values in different cultures differ, as they do also between individuals. (Aalto 2010; Masini 1993.)

3.6.2 Environmental scanning

As method for analysing change in certain phenomena, environmental scanning encompasses monitoring, observing and understanding the events and choices behind the said phenomena and their consequences. Determining the forces behind change is one of the key steps of futures research processes. In environmental scanning, trends, megatrends, weak signals, wild cards and driving forces are identified and analysed. (Aalto 2010.)

A *megatrend* is usually a global phenomenon that has a great impact on society. It is usually rather autonomous, and it is difficult to determine the underlying causes behind the phenomenon. Its impacts are significant both nationally and internationally, from both social and economic aspects (at least). There are various viewpoints from which megatrends can be viewed, and it could mean that some megatrends do not appear to be megatrends from another point of view. Personal, institutional, methodological, cultural and ideological factors may influence the recognising of megatrends. *Trends*, on the other hand, differ from megatrends in that they do not have such enormous effect on society. Trends are more easily anticipated and are usually generally known. An example of the differences between trends and megatrends can be found in climate change: when considering from the point of view of polar bear habitats shrinking, climate change is a megatrend. However, when examining the development of the Earth's weather cycle during millions of years, climate change is a trend. (Aalto 2010; Rubin 2005.)

Weak signals are difficult to define and to identify. They are new phenomena, also referred to as emerging issues, which can lead into new radical events or other phenomena. A business man spotting a weak signal and reacting to it may earn a great deal of money, while others may experience losses. Identifying weak signals decreases the severity of risks, although they cannot always be seen as reliable since

they are often spotted through irregular channels. A piece of information gained through research or a symptom of an upcoming change can be considered a weak signal. Weak signals often change megatrends or create new ones. An example of a weak signal could be the New York terrorist attack on the World Trade Centre. It was an unimaginable event, and yet, after the incident, the vulnerability of the towers was unconsciously realised. (Rubin 2005; Aalto 2010.) There had even been some references to a similar incident prior to the event, such as in a book on uncertainty by Nassim Taleb (Taleb 2007). *The Black Swan* offers a reminder of the importance of uncertainty: it is a very human trait to search for answers that back up our own views, and even though historical facts ought to give a lesson on the forces of uncertainty, it is still difficult for people to prepare for the unknown. In fact, historical accounts can be distorted and the only way to avoid the impact of these black swans, unexpected events, is to stop assuming anything. (Taleb 2007.) These views are important to bear in mind when researching pasts, presents and futures.

Wild cards, on the other hand, are also unlikely to occur and difficult to predict. They are events and phenomena which, when they do happen, can cause dramatical effects. Examples of wild cards are terrorist attacks, a natural disaster or a pandemic. (Aalto 2010; Petersen 1999.)

Driving forces or drivers are phenomena occurring on a wide scale, which guide decision-making and choices, so-called drivers of change. They are related to attitudes and values, reflecting the current customs, processes, people or issues. They can be concepts of how things are currently or what is right or true. Also social situations, religions or shared events in the past can be considered as driving forces. Unlike megatrends, driving forces do not necessarily continue, but they do have an impact on choices either on a conscious or unconscious level. They are generally accepted phenomena which are not usually stated or questioned, like political correctness and dress codes. (Rubin 2005.)

In the environmental scanning process, megatrends, driving forces, weak signals and potential wild cards are identified by picking up signals from the environment; in a word, the environment is *scanned* for signs of events and developments. The future of the studied phenomenon is evaluated based on the discovered signs from the environment. (Bell 1997.) A useful method for gaining information on the forces of change is by expert interviews, which is a method used in this research. The

experts are interviewed in the case studies, as well as being further challenged in a Delphi survey, both of which are further described in the following chapter.

With the help of environmental scanning, it is possible to identify the signs of upcoming change. Environmental scanning can be used for evaluating the state of the economy or society, and it can help in preparing for events that may lie in the near future. A successful scanning process also includes the ability to react to the changes: whether it is preparation or an attempt to influence the potential outcome by active intervention. (Bell 1997.)

3.6.3 Mind mapping

A useful tool for determining the environment of the studied phenomenon is the PESTEL framework, which was already introduced in the previous section 2.1. The wide range of aspects - political, social, ecological, economic, etc., are more easily conceptualised when approached using the PESTEL framework (Thompson 2002), as it is necessary to understand the impact of the phenomenon to its entire environment. It is also useful to use a mind map as a method to identify the various dimensions of the PESTEL aspects. A mind map can be used to determine the overall effects and impacts of ecological sanitation on other aspects of society, much like the PESTEL model, but more in-depth. This is relevant concerning the second research question. With the help of a mind map, it is possible to clarify thoughts and links between issues, taking into account the impact from future trends, events, weak signals or decisions. The impacts can be directed to the phenomenon on several levels, with most affected or overall concepts closer to the centre and less important factors further out. (Glenn 2009; Rubin 2002.)

The mind mapping method is most often used in, e.g. defining the impact of current trends and potential future events, organising thoughts linked to future events or trends, creating predictions based on varying scenarios, or pointing out complex relationships between events or phenomena; here, the wheel is used for the latter example.

The wheel is drawn by placing the phenomenon in question in the middle, and then linking primary impacts or links to it by drawing lines. Then, the impacts of primary effects are drawn on further outside of the circle, linking effects which have

a causal relationship together with lines. Eventually, the picture presents the said phenomenon with several level impacts or events in a circle. Thus, a clear picture of the consequences of a trend or event is achieved. (Glenn 2009.) A mind map of ecological sanitation is portrayed in Figure 5 (Chapter 4.2).

3.6.4 Scenario methodology

In futures research, environmental scanning and mind mapping, as described above, can be used as individual methods or be tied together with wider analysis, as is done in this research, where the above mentioned methods act as supporting building blocks for futures scenarios.

Scenario methodology is used to attract interest and discussion on future prospects. Scenarios are a chain of events that lead to a certain outcome – rather than giving exact predictions, they often form potential futures, out of which many can be correct. (Juslén & Halmari 1984.) The scenarios must be plausible, as well as internally consistent. When successful, they take into account the driving forces of the present, as well as the growing trends and visible weak signals that can be identified. (Rikkonen & Tapio 2009.)

When discussing potential or preferable futures, it is important to determine the criteria for the outcomes. The criteria can be based on law and norms, values or institutions, public or elite opinions. A scenario is a way to summarise futures research, whether it be qualitative or quantitative in nature. (Bell 2008.)

When working on scenarios, it is possible to try to determine the favourable outcome of the future, or concentration can be on the paths towards a range of potential futures. Scenarios can be derived by using methods such as mind mapping images of alternative futures or modelling the various perspectives on past, present and future developments. Also data gathered in a Delphi survey can be used to create scenarios. (Rikkonen & Tapio 2009.)

In the process of scenario work, it is important to first identify the contextual environment and the driving forces affecting the phenomenon. In this research, this has been established with the help of the mind map, as well as expert interviews. Then, to construct the scenarios, the FAR method is used (described in the following chapter). The scenarios are constructed for the specific purpose of studying the

potential outcomes, such as is the case in this research, or produce the desired future. (OPH 2014.)

3.6.5 Field Anomaly Relaxation (FAR)

As explained above, one method for scenario work is Field Anomaly Relaxation (FAR), a method which was developed in the United States in the 1960s. (Nurmi 2006.)

A scenario is a series of logical future images which are linked together in a future path. A scenario points out the actors and cause-and-effect relations between various events and phenomena. The FAR-method (Figure 4) is useful when creating the various future frames, from which the scenarios are then formed. (Nurmi 2006.)

The thought process of the FAR-method can be seen from the figure drawn by Seppälä (1983). The process includes information gathering (ii), often done with the help of expert interviews, environmental scanning, PESTEL, mind mapping and other methods, but the ones mentioned here will be used in this research. The process helps to formulate future variables and statuses, which in turn will influence the outcome of scenarios. The future table is constructed (iii) by identifying important aspects of variables that have an impact of the studied phenomenon. These variables, together with megatrends, weak signals and other signs of potential development, form a series of outcomes which are portrayed in a table format. (Nurmi 2006; Rubin 2005.)

Once the table is set and dependencies between variables have been identified (iv: there are often variables which cancel each other out; in principle, there cannot be unemployment and full employment in the same future image), the future images are constructed (v) based on the different statuses of the variables. These images are like snapshots of the potential futures. It is then time to create the future paths (vi), which depict the process of how the image was reached. The paths can move from one image to another, and so, with the help of future paths and images, scenarios are formed. (Nurmi 2006.)

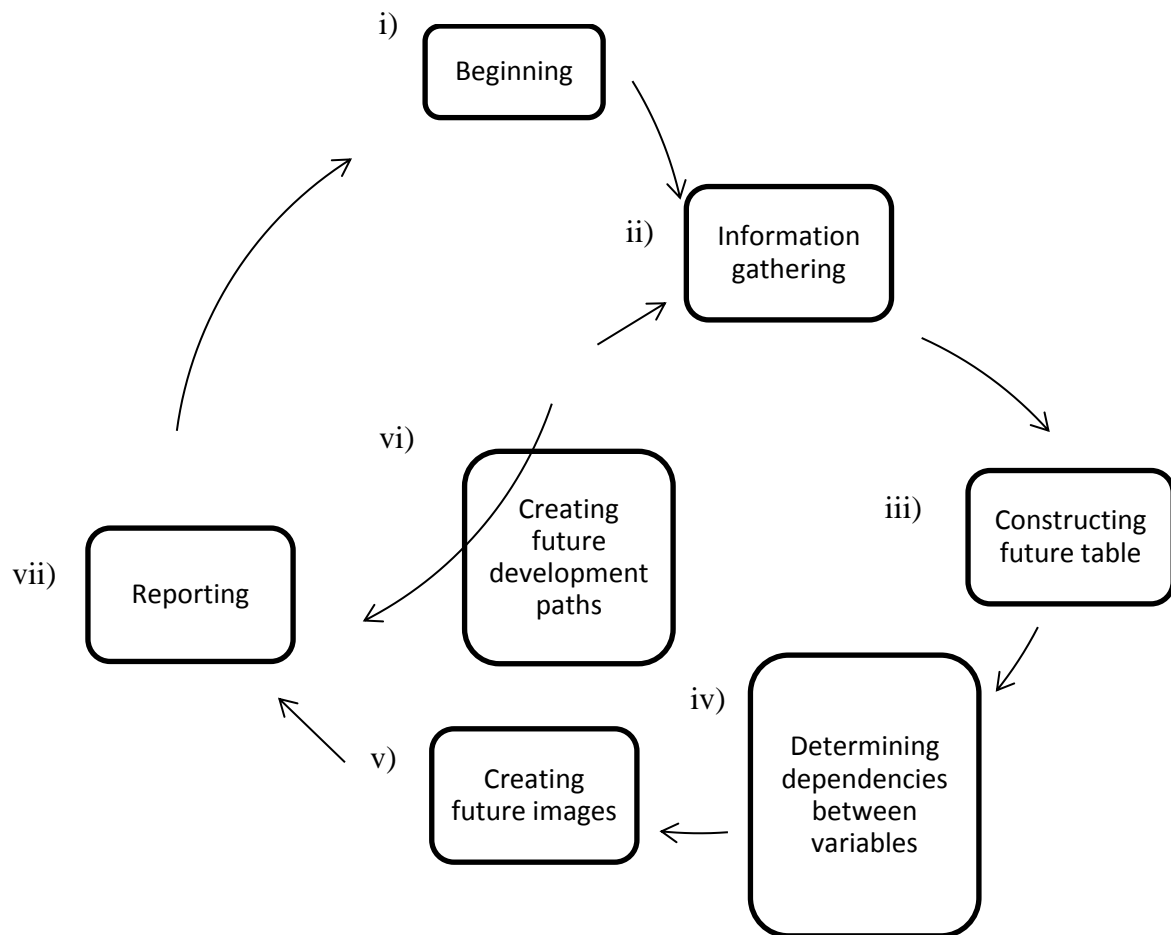


Figure 4: The FAR-method according to Seppälä (1983), modified by the author.

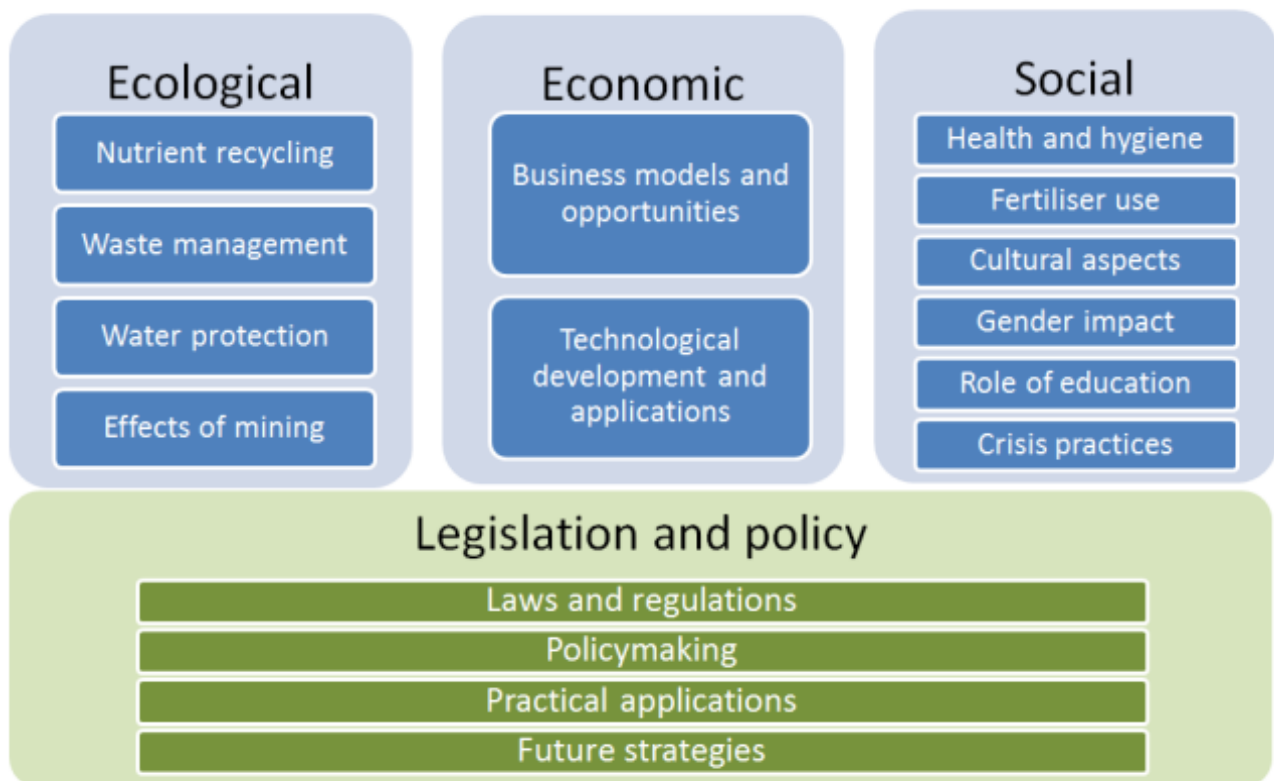
The scenarios are not predictions of the future, but rather logical stories of potential futures, which could happen. There are usually at least three different scenarios formed in order to ensure that the question is not between the most desirable future and its opposite scenario. It is also necessary to use various sources to determine what could potentially happen in the future: not all desired futures are possible. (Rubin 2005.)

Sanitation is more important than independence.
-Mahatma Gandhi

4. Sustainability in sanitation

Sustainable sanitation has been mentioned as a term several times in this research, but what does it mean? In this chapter, the background of sustainable sanitation and its need are described, together with previous research done related to the matter. The chapter is divided into three main parts – ecological, economic, and finally social and cultural sanitation – to emphasise the three pillars of sustainability. Eventually, the discussion will turn towards legislation, which has not been studied as widely as various ecological or biological issues, for instance. This literature review justifies the focus on legislation and policy in terms of sustainable sanitation, and this chapter is where the research will be later built upon (see Table 2).

Table 2: Typology of the themes of the previous research in comparison to this research.



4.1 World in need of relief

The world is in need of water, sanitation and hygiene (WASH) and the greatest need of these is that of sanitation.

One should not forget that major gains have been made over the years. Between 1990 and 2010, over 2 billion people gained access to clean drinking water source and as many as 1.8 billion people gained access to improved sanitation facilities. This means that work is being done and tremendous efforts put into the issue. But these results tend to be forgotten once it is pointed out that still we have 2.5 billion people without access to improved sanitation, and over a billion who practice open defecation. (WHO 2012.) The numbers are so huge that it is difficult to understand it: we are talking about 40 % of the world's population. Thousands of people die in vain, water bodies eutrophicate, the environment degrades, economies fall – because of the lack of effort we put into WASH.

Sanitation is one thing, but to make it sustainable, affordable, ecological – in a word, a sensible option for those who cannot afford food or education – that is another.

The world is facing a critical challenge. Natural resources are depleting, the environment is facing deterioration in many places and people are suffering from diseases brought on by poor living standards and changes in their living environment. Sustainable solutions and multi-sectoral policies are required to tackle the challenges faced by the global village. The international community agreed on the Millennium Development Goals (MDGs) to solve serious issues, such as poverty and environmental degradation but the success has not been overwhelming. (Baum *et al.* 2013; WHO 2012.) The post-2015 targets, dubbed the Sustainable Development Goals (SDGs) are still under development, but it has been decided that water, sanitation and hygiene issues are of great importance. Compared to the MDGs, a more holistic – and ambitious – approach is likely to take form. As sanitation has been recognised as a human right, a better basis for setting new goals has been established. (UN 2012; Bradley & Bartram 2013.) It has also been noted on several occasions that sustainable sanitation plays an important role in achieving both MDGs and SDGs (e.g. Heinonen-Tanski *et al.* 2010; Panesar *et al.* 2010; Esray 2002).

Sustainability, achieved successfully, encompasses the three aspects: economic, ecological and social. This means that economic decisions should not be made without acknowledging the environmental and social implications of each decision – and vice versa. This definition of sustainability, introduced by the report of the Brundtland Commission already in 1972, sets a basis for a multidisciplinary and multisectoral approach. (Brundtland 1987.) Bearing in mind this three column view of sustainability, this chapter aims at introducing one solution to a problem involving phosphorus resources, clean environment and water, as well as public health in terms of sanitation.

Furthermore, in order to achieve sustainability, a closed cycle should be aimed at instead of an open cycle. This means, quite simply, that in any production method or system which operates by recycling, the same material is used, so that no new material enters the cycle. By aiming at closed cycle systems, material recycling becomes more crucial – but especially in cases where raw material is difficult or expensive to extract, recycled material utilisation is often a better option, both environmentally and economically. A good example of this is the diminishing phosphorus resources which could be compensated by using human excreta as fertiliser; a method called ecological sanitation could be the sustainable solution that is required. (Bracken *et al.* 2006; GDTA 2012.)

Ecological sanitation has been studied from several aspects, although legislation, policy level and sociological behaviour have not been amongst the most common viewpoints. In this chapter, the leading research of the field is introduced. The discussion will include research that is most recent and connected to the topic at hand – the implementation of ecological sanitation. The chapter is divided into three parts, which roughly divide the issues into ecological, economic and socio-cultural aspects. The following chapter on the ecological viewpoint deals with the history of sanitation, closed nutrient cycle, organic human excreta as waste, effects of phosphorus mining, as well as environmental degradation in general. The economic aspect encompasses business opportunities related to sustainable sanitation, as well as various types of technological development. The final category is social and cultural sanitation, which handles matters on health and hygiene, habits in terms of fertiliser use, cultural traditions on sanitation, gender and education, and sanitation in crisis situations. *At the end of this chapter, a closer look is taken into research on legislation and policy, which is dealt with in more depth in this dissertation.*

4.2 Ecological sanitation

Ecological sanitation (ecosan), involving the proper treatment of wastewater and nutrient recycling, returning the nutrients back to nature and achieving a balance between community development and the environment, is socially, economically and ecologically a sustainable option, thus covering all three pillars of sustainability (Brundtland 1987). It is also an ancient method, as “humanure” has been considered as a fertiliser as long as agriculture has been practiced. Yet, with the development of waterborne sanitation, the practice has been deemed unhygienic and thus forgotten, even banned in some countries, even though it should be viewed rather as a wholesome closed-loop system for managing human excreta (Esray 2002). But what determines the development of a practice becoming a norm or a trend? Why did attitudes regarding ecosan change and could they change back, bringing the ecological back to sanitation?

Human beings, just like any other animals, eat food which is then digested and used as energy. The part that cannot be consumed is excreted, and the leftover nutrients are returned back to the natural cycle. Wild animals do their “business” on the soil, and so their excreta return the valuable nutrients to enrich the soil. However, humans in many countries mix their waste with water and allow it to eutrophicate and pollute the water used for washing and drinking, which may easily lead to epidemics if not properly treated and managed. The development of waterborne sanitation and inadequate treatment of wastewater has made contaminated water a serious public health problem in many developing and industrialised countries, causing severe cholera and typhoid epidemics (Vuorinen 2007).

In ecological sanitation, the nutrients and organic matter present in human excreta are considered resources, which enable the healthy ecology of beneficial soil organisms that eventually produce food and other benefits for people. It has been estimated that one person can produce as much fertiliser as necessary for the food needed for one person (See Table 3). This could benefit not only sanitation and the water sector, but also food production and the fertiliser industry. (Gajurel & Wendland 2007.)

Table 3: Nutrient amounts of toilet waste produced by one individual annually. (Weckman 2000.)

	Urine		Solid excreta		Toilet Waste
	Kg/person/a	%	Kg/person/a	%	Kg/person/a
Weight	329-438		26-51		365-511
Nitrogen (N)	4,0	89	0,5	11	4,5
Phosphorus (P)	0,4	67	0,2	33	0,6
Potassium (K)	0,9	69	0,4	31	1,3
Total NPK	5,3		1,1		6,4

The major advantages of ecological sanitation are the improvement of soil condition and fertility, preservation of fresh water from pollution and excess consumption, hygienic safety, food security, low cost, reliability, flexibility according to place, environment, culture and economic conditions, and preference for modular, decentralised partial-flow systems. The separation of urine, which contains high levels of nutrients, from excreta makes the reuse possibilities easier. Excreta are even 10 times smaller in volume than urine and contain most of the pathogens, so it is easier to manage hygienic conditions and collect most of the nutrients. Furthermore, the quantities of separated grey water, *i.e.* washing water from the kitchen, shower and laundry, are lower as grey water is low on nutrients and does not need as strict treatment as black water containing all toilet waste. (Gajurel & Wendland 2007; Tchobanoglous & Leverenz 2013.)

The various aspects of ecological sanitation can be found with the help of Figure 5, which shows the links between the various benefits, such as found in the PESTEL framework, as well as potential future trends.

4.2.1 Historical aspects

For thousands of years, nearly as long as cultivation has been practiced, human waste has been used in the fields as soil fertiliser. Already early on it was understood that nutrients consumed by humans and animals should be returned back to the soil to help growing crops. It was also understood that human waste, when mixed with

water sources, ruins the water and spreads disease – humans have a natural instinct to avoid water with an unpleasant odour, and already ancient civilisations enjoyed complex sanitary systems. (Vuorinen *et al.* 2007.) The first “Western” type toilets were in use in the Indus culture, around the regions of modern Pakistan, about 4500 years ago (Heikura 2007). Furthermore, the first written instructions on composting toilet waste were given as early as during the Qin and Han Dynasty (221-206 BC and 206 BC-220 AD) (Vuorinen *et al.* 2007).

However, some hundred years ago when cities were growing and the amount of waste increased, it was determined that the best solution to discard toilet waste was to transport it out of sight by means of water. Water borne sanitation became popular first in cities, later even amongst the poorer people, and waste bothered the city dwellers no longer. (Vuorinen *et al.* 2007.) The water closet we know these days was developed by Sir John Harington (1561-1612), and was further improved by Alexander Cummings and Joseph Bramah at the end of the 18th century. Overall, the water closet has been rather British in its origins. (Heikura 2007.) Nevertheless, already at the time of the development of the modern water closet, the connection of waterborne sanitation and increase in cholera cases near public water wells was understood. The method was considered clean and effortless – and it is still considered as the norm for sanitation facilities, even in countries where fresh water resources are scarce.

It is unfortunate, however, that the sanitation developers of *olden days* did not realise the implications of diverting human waste into water bodies. Human excreta, rich in nutrients such as nitrogen and phosphorus, is a plentiful resource, but when left untreated it can contaminate vast lakes, rivers and groundwater sources. Today, most developed cities have wastewater treatment facilities, but this is still far from the norm – and even the most modern facilities fail to treat all the waste produced by cities as overflows in pumping stations and by-passes in wastewater treatment plants occur regularly. As a result, nutrients, such as phosphorus, find their way into water bodies, where micro-organisms thrive on the extra nutrients – a process which eventually leads to eutrophication.

Yet, one does not have to travel too many centuries back in time before dwellings without any type of nearby latrines can be found (bear in mind, this is still true today in many parts of the world). Let us examine, for example, Finland, which can

demonstrate the development of sanitation from a developing country to a modern welfare state.

Only 200 years ago indoor toilets, and even outhouses, were a far cry from being a norm, as it was more sensible to use the human excreta as fertiliser on the fields. Even when toilets emerged, only the richest could have a toilet in their house instead of behind the barn. Barely a hundred years have passed since the appearance of the water closet (WC), and it did not become popular until the 1860s – in fact, it took 20 years to accept the first flush toilet at the turn of the 18th and 19th century. (Nygård 2004.) Today, almost every household in Finland has a WC, even though more than 0.5 million people still live out of reach of a municipal sewage network (Helminen *et al.* 2013). Nevertheless, an ecological option, the dry toilet, has re-introduced itself and is slowly becoming a more acceptable option for sanitation, even in urban environments. This ecological solution not only saves water but also returns nutrients back to nature – much like the defecation methods of people some hundreds of years ago.

Thomas P. Hughes (2000) argues that “history tends to repeat itself in broad patterns, if not in details”, and thus it is possible to anticipate the effects of future technological changes. Bearing in mind this cyclical nature of development, it could be argued that in terms of sanitation we are simply going around in circles. The “new” ecological sanitation method is not so new after all, although often the idea is sold like one. At the same time, we can see people in developing countries living without proper sanitation, because these people would like to invest in a waterborne toilet which they cannot afford. In fact, they want to go through the same cycle as we did with sanitation: from non-existent to poor sanitation and onwards to water closets, and finally (as well as hopefully) ending up with a hygienic yet ecological dry toilet. But why is it so?

It can be challenging to discover new innovations, or even return to the past. There are numerous rules, regulations and standards to take into account, which sometimes seem unjust, unclear or simply insane. It may be difficult to see how laws and regulations have come into being and what motivates the decision-makers to maintain such laws.

4.2.2 Closing the nutrient loop

In today's world, it is sometimes difficult to understand the importance of closed loops. While discussing wastewater management, we are also discussing the nutrient cycle – and whether it is successful. It is understood that soil provides plants with nutrients. As the plants are harvested and eaten elsewhere, the nutrients leave the soil, leaving it less and less fertile every year. Fortunately, humans have discovered a way to renew the soil's fertility. As mentioned, animal manure has been used for thousands of years, as well as so-called “humanure” – and these days the chemical fertiliser market is quite successful indeed. There was a point in time when fertile manure became waste, and this happened around the same time as towns grew, together with the amount of waste, and new technologies were developed to benefit agriculture. Manure was no longer needed; it was easier, and at that point, cheaper, to flush it away out of sight. (Nygård 2004.) It is not that there is insufficient (hu)manure to cover the fields: after all, it is an endless resource. Rather, the nutrients found in it are being deposited into lakes and oceans rather than the soil due to insufficient (or non-existent) wastewater treatment, which is why we have turned to mining chemical fertilisers.

Phosphorus, such an important nutrient for plants, can also be extracted from phosphate mines. Mining is often harmful to the environment and can have serious side-effects. Without getting into the issues of mining, phosphate extraction has one major flaw: the deposits are running low. Some experts estimate that as quickly as in 30-50 years, phosphorus resources will have been depleted, which in turn would present a problem to the fertiliser industry. The more optimistic estimations reach up to 350 years. (Cohen *et al.* 2011; van Vurren *et al.* 2010.)

So, put simply, we mine phosphorus to fertilise our fields which have become infertile, and at the same time we flush our waste, containing phosphorus, to waters which have become eutrophicated. Both of these practices have proven to be problematic, which is no wonder, as we have forgotten the basics of the natural cycle. Nutrients have been designed to stay within the closed loop (see Figure 6). An animal eats a plant, digests it and excretes the waste on land; the nutrients return to the soil where they provide nutrition for plants to grow, so they can be eaten by animals, and so it goes, on and on. For some reason, humans have disrupted this cycle.



Figure 6: Closed cycle in sanitation (GDTA /Pylvänen R. 2014).

In order to achieve a closed cycle of nutrients, it is necessary to contemplate the environmental issues of ecological sanitation. These include the re-use opportunities of human excreta and wastewater, as well as more detailed questions on diminishing phosphorus and ecological fertiliser use. It is often a question of legislation as to whether or not it is possible to produce and/or use treated human excrement as fertiliser. (Esray 2002.)

4.2.3 Waste or product?

Certainly, humans have a reason for separating their waste from their food. As mentioned above, humans have an instinctive behaviour to avoid foul water, and the taboo of defecation is common in most cultures. Even without scientifically knowing it, humans have known the dangers of excreta. (Vuorinen 2007.)

Obviously, it is not possible to build sufficient sewage networks in vast rural areas or dense slums. The problem is not just with the infrastructure but the lack of water – many areas where sanitation is lacking have a serious deficit of potable

water. There is no way clean water will be flushed down the toilet while people do not have enough drinking water. The problem with the other common option – pit latrines – is that they do not provide proper containment for the excreta. Rains and floods often flush the waste (and the bacteria) into the streets and water bodies, not to speak of the contamination of groundwater due to infiltration from pits.

The option here is a proper ventilated dry toilet: a toilet without water, proper ventilation to avoid odour and adequate containment of faeces. In most “advanced” models also urine diversion is an option, which keeps the faeces dry and odourless. Dry toilets offer another advantage over a water closet or a pit. The dry matter, faeces, can be composted into safe, hygienic soil. The composted soil, especially with diverted urine, is an excellent source of fertiliser. Very promising results have been achieved by using either composted excreta or diverted urine. (GDTA 2012; Richert Stintzing 2007.)

Surely, this is not a new invention. After all, wastewater treatment plants have used the sludge in landscaping, and, as said, dry toilets were the option before sewage systems became popular. However, the wastewater treatment process includes additional components, such as industrial waste, which then could find its way into the soil. Indeed, wastewater sludge is tested for heavy metals before being used for fertilising purposes. According to several pieces of research (e.g. Pradhan 2010; Schönning 2002; Winblad & Simpson-Hébert 2004; WHO 2006), the fertiliser from a composting dry toilet, is, however, practically safe, as the composting process destroys bacteria and the diverted urine is practically sterile - especially when stored in a closed container for 1-3 months. Tests on the use of diverted urine and composted faeces have been conducted, and more are on the way; research on drug and hormone traces and their effects are on-going in various research groups. (Pradhan 2010; Vinnerås *et al.* 2008, Malisie *et al.* 2007.) Furthermore, according to Vinnerås (2002), the majority of heavy metals found in sewage originate from grey water.

Some of the studies on the reuse of toilet waste as fertiliser were already covered when discussing health, but reuse has also been studied from an agricultural and technological point of view (see e.g. Malisie *et al.* 2007, Heinonen-Tanski *et al.* 2010). Inexpensive fertiliser is also beneficial in poor areas where fertiliser and food prices are higher than people can afford. It is also important to take into account that

phosphorus resources are diminishing and alternative sources for fertiliser must be developed. (Cohen *et al.* 2011.)

The yields of various crops have been found to be excellent using only urine or composted excreta with permissible limits of pH and salt content, as well as with increased NPK rates. (See, e.g. Srinivasamurthy *et al.* 2012.) Many dry toilet methods also take into account energy production and bio waste management, as bio waste can be treated in the same way as faecal matter and biogas can be used in local energy production (Ward *et al.* 2014). It has also been found that separated urine and faeces work better as fertiliser than when combined. (Otterpohl *et al.* 2012.) Studies also indicate that no trace elements or heavy metals occur in diverted urine, making it safe for fertiliser use – also the collection of mineral ammonium bound from human urine has been deemed safe. (Laiho & Eklund 2012.)

However, using human urine as fertiliser does cause some challenges. In addition to pathogens and pharmaceuticals (discussed further in section 4.4.1), urine contains some salts. This means that frequent use of urine may cause increased soil salinity and sodium accumulation in soil, which may disrupt the water and nutrient intake of the plants. (Sene *et al.* 2013). Furthermore, it has been found that over 50 % of sodium stays in soil after cultivation (Sene 2013). However, studies indicate that some amounts of human urine may be used without harming the plants, assuming sodium removal is attempted in excessive use (Sene *et al.* 2013). It has also been argued that when urine is used in irrigation diluted with water, the total salt quantity is not high compared to irrigation water (Dagerskog & Bonzi 2010). Nevertheless, it is clear that more research into salt accumulation when using urine as fertiliser is required, especially in large scale applications.

Business opportunities provided by the reuse of toilet waste as fertiliser have been studied. Research shows that faecal sludge management is a lucrative business opportunity that should attract entrepreneurs for the collection, transport and reuse of the product in various ways. (Mynepalli *et al.* 2012.) More about the economic value of ecological sanitation is presented in section 4.3.

Urine and composted faecal matter should not be considered so unhygienic – after all, the reuse of wastewater has been studied and practiced across the globe. For instance, the experiences in Nicaragua (WSP 2012b) and Finland (HSY Water Services 2012) are encouraging, although the technologies used still leave something to be desired. Especially when industry wastewater is mixed together

with household waste, it is difficult to extract the harmful substances from the useful nutrients.

4.2.4 Problem with a capital P

Promoting ecological sanitation and the natural cycle of nutrients is not only a matter of getting the nutrients out of water into soil. The problem is that mined phosphorus does not come without risk. Phosphate rock has a variety of characteristics, depending on its origin. Most high quality deposits have already been exploited and the remaining ore has a lower phosphorus content. This often means that the ore has a higher content of associated heavy metals such as cadmium and uranium, most of which find their way into the fertilisers as they are difficult to extract. (Cohen *et al.* 2011.) It has been estimated that peak P will be reached by 2040 (Driver *et al.* 1999; Cordell *et al.* 2011; Mohr 2012).

In most countries, restrictions have been set for cadmium and uranium content in fertilisers, but these heavy metals still pose a toxic threat (Cohen *et al.* 2011; Cordell *et al.* 2011). Furthermore, if fertiliser exceeds the safe limits, it cannot be used and the refining process can become extremely costly. This is reflected, in turn, in fertiliser prices as well as in food prices. It is also economically sustainable to recycle phosphorus instead of mining it. This could also allow countries to achieve so-called phosphorus sovereignty, as human waste is produced everywhere, unlike phosphate mines, which can be found only in certain locations. (Cordell *et al.* 2011; Wyant *et al.* 2013.)

Still, also recycled phosphorus can present challenges. Sewage sludge contains not only phosphorus but also nitrogen (75 % of N, 50 % of P and 50 % of K in sewage water originates from urine). Urine is also very diluted, and thus comes in large volumes, which are difficult to handle. (Cohen *et al.* 2011.) Using urine diverting toilets would be a sensible option, especially when discussing large scale collection of waste. Also diverted urine can be used as fertiliser; diluting it with water would save resources on irrigation. (GDTA 2012; Driver *et al.* 1999.) The problem with utilising diverted urine (as well as treated wastewater) is logistics: it is difficult to move vast quantities of liquid from A to B.

Several techniques have been developed to improve the nutrient recycle in urine and wastewater. The waste can be incinerated and the ash used as fertiliser; most of the nutrients remain in the ash. (Cohen *et al.* 2011.) Diverted urine can also be treated as wastewater, separating the water from the nutrients but without the potentially harmful chemicals from industrial wastewater (GDTA 2012; Driver *et al.* 1999). In general, the smaller the quantities, the easier it is to transport and spread the fertiliser, unless onsite practices are being used.

Another challenge is presented by the type of phosphorus. Most rock phosphates are insoluble in water and soil. In fact, the ferrous sulphate used to clean wastewaters tends to bind phosphorus so that it is not in its most soluble form when sludge is composted. (Cohen *et al.* 2011; Wyant *et al.* 2013.) This is another reason to favour the natural source – composted straight from the dry toilet. Urine diversion in a dry toilet is an option but not necessary, as the composting process can occur as long as enough composting agent, such as peat, is added to the excreta. (GDTA 2012.)

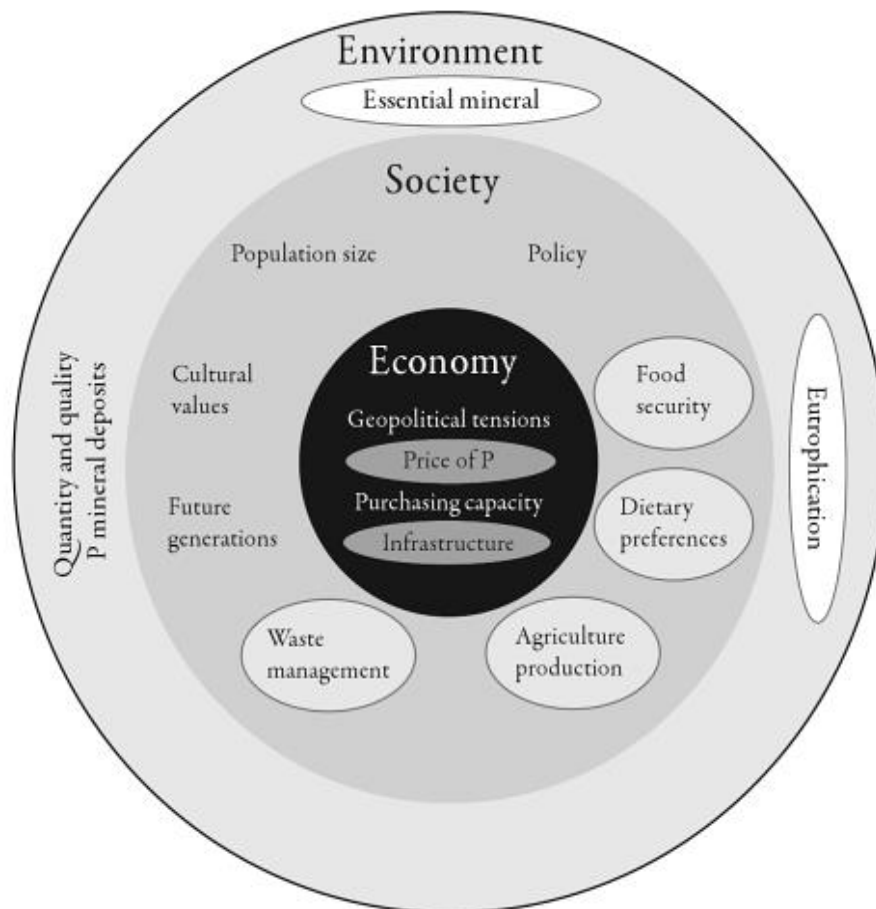


Figure 7: Phosphorus management in relation to sustainable thinking. In Wyant, Corman & Elser (2013).

4.2.5 Environmental degradation

The nutrients can cause problems for the ecosystem as they find their way into water bodies. Eutrophicated lakes, rivers and oceans struggle with our waste. In vast oceans the difference is not noticeable, but smaller lakes and rivers have quickly turned into green puddles full of algae. Most of the phosphorus and nitrogen emissions in waters are from agriculture. (HELCOM 2013.)

The application of excreta and greywater to agricultural land reduces the direct impact on water bodies. However, the nutrients may still percolate into groundwater or be flushed into the surface water if applied in excess. The impact is still reduced to that of water bodies being primary recipients of excreta. (Gajurel & Wendland 2007.)

The environmental impact of different sanitation systems can be measured in terms of conservation and use of natural resources, discharges to water bodies, air emissions and impacts on soils. A life-cycle assessment (LCA) of various on-site wastewater treatment facilities indicates that the lowest cause of eutrophication or total life-cycle carbon footprint is produced by the use of dry toilet and greywater treatment system. Septic tanks or treating toilet waste together with greywater did not produce as good results. (Lehtoranta & Vilpas 2012; Remy & Jekel 2008). Ecosan appears to be useful especially in small scale sanitation systems, and can reduce the environmental damage by 60 % compared to any conventional systems. In larger scale sanitation, ecosan is not likely to replace the low water consuming conventional systems. (Benetto *et al.* 2009.)

The greatest environmental risk from waterborne sanitation comes from toilet waste, which contains approximately 90 % of nitrogen, 80 % of phosphorus, 80 % of total oxygen demand and 98 % of faecal bacteria in average household wastewater. Thus, the efforts towards reducing the environmental impact of wastewater should be directed initially towards toilet water and only secondarily to greywater. Reductions in phosphate levels in detergents will, in turn, help to reduce the nutrient load of greywater. (Särkelä & Lahti 2013; Travis *et al.* 2010.)

4.3 Economic sanitation

The second pillar of sustainability is the economic aspect. The impact of adequate sanitation on the economy can often be overlooked. Nevertheless, a society cannot function if sanitation is not properly taken care of. Developing sanitation can also give a great deal of push to local entrepreneurship and innovation.

4.3.1 Business opportunities

In improving sanitation, the additional benefits are often forgotten. In addition to improving the state of public health and clean environment, a functional sanitation system also improves the economy of society as well as an individual.

Especially in rural areas, where many households grow their own food, there is a dire need for fertiliser. An affordable solution, such as composting and/or urine diverting toilet could be an alternative to expensive artificial fertiliser. Many households in several countries have, after the introduction of dry toilets, been interested in substituting their use of artificial fertiliser, at least in part, with human based fertiliser. (See, e.g. Petterson & Wikström 2012; Andersson 2014.) This has not only been done on a household level, but also larger farms have experimented with recycling the nutrients from human excreta, often by using treated or composted wastewater or sludge. In these cases the yields have grown, and the attitudes have eventually been accepting towards the fertilising method. Yet, current legislation in some countries limits the use of “humanure” to only landscaping, and not farming. (HSY Water Services 2012; Jiménez 2012.)

Apart from fertiliser use, sanitation does bring other forms of employment and livelihood. First of all, there is a growing need for people who know how to build and maintain toilets. Also in industrialised countries the skills required to build a functioning indoor dry toilet are rare. (O’Connell 2014.) The construction process is one thing, but also the maintenance and collection of the waste need to be organised well, especially in an urban community where people do not necessarily have their own gardens. In some countries, e.g. Sweden, the projects have moved on from pilots to more wide-scale municipal implementation, but on the whole there is still a long way to go – even though these service providers already exist in the form of emptying septic tanks, for instance. (Johansson *et al.* 2009.)

Sanitation also brings new opportunities to the energy sector, as the composting material can be used as a source of bioenergy, too. This is useful especially in rural areas outside the power grid, but the uses can be extended to more modern locations to add to power use. (Otterpohl *et al.* 2012; Gamisonia 2012.)

Moreover, it is necessary to remember to look at the bigger picture. With adequate sanitation, there are more opportunities for tourism, recreation and healthy living for both inhabitants as well as guests. National parks, holiday reserves and other locations have benefited from good dry toilets, which are affordable and easy to maintain. (Cant 2009; Kiukas 2011; Regerand *et al.* 2009.)

4.3.2 Technology

It is important to consider not only the question *why*, but also *how* ecological sanitation can be made into a feasible option. Several researchers have developed, tested and evaluated various models, as well as tested their suitability in different conditions and environments. Some of them are described below.

Ecological sanitation can be achieved in numerous ways. Dry toilets come in many forms, but basic composting toilets and urine diverting dry toilets (UDDT) are the most common models in rural and poor areas without electricity. More technological approaches are offered by freezing, incinerating, evaporating and other forms of toilet. In disaster areas, a decomposing bag toilet might become just as handy as an old fashioned dry toilet – especially if no sanitation facilities exist. In rural areas with no sewage network, a dry toilet with grey water treatment system is usually the cheapest as well as the most ecological option (Lehtoranta & Vilpas 2012; Panesar *et al.* 2010).

Furthermore, the latest technological innovations have been used to improve ecological sanitation, from nanotechnology to state of the art diversion and evaporation systems, which collect the important nutrients and discard the unimportant part. It is also the goal of the wastewater treatment industry to improve the nutrient intake in the wastewater treatment process and recycle most of the nutrients safely and affordably. (Qu *et al.* 2013; Sharma & Sharma 2012; Schönning 2002.)

There are various models of toilets that support the ecological sanitation approach. The Ventilated Improved Pit (VIP) latrine is an easy-to-build dry sanitation option for rural areas. It is simply an ordinary pit latrine that has been fitted with a vent pipe and a fly screen to remove smells and prevent flies from entering the toilet. As the toilet includes a pit, it is necessary to construct it at least 50 meters from the nearest well, borehole or spring to avoid contamination of the groundwater. It is not ideal for areas with a high water table, even if the pit is lined, but it does offer an affordable dry sanitation option for many rural and dry areas. It is also possible to build a VIP with two pits: when one is not used the contents are being composted, and after the composting period the pit can be emptied for fertiliser. This method is also known as the Fossa Alterna toilet. (CSIR 2012.)

The Urine Diversion Dry Toilet (UDDT) is ideal for practicing ecological sanitation. They also come in many shapes and models, and are suitable for nearly any location. The key feature making a UDDT different from an ordinary toilet is the separating capability. The urine is separated in a seat with two holes or another mechanism for separating the liquid from the solid excreta. Some models separate liquid at the bottom of the storage unit, which makes the liquid more unsanitary than basically sterile urine. (CSIR 2012; GDTA 2012.)

In emergency situations it is not always possible to build a permanent facility for sanitation. In these conditions, alternative solutions, such as the Peepoo sanitation solution (Wirseen & Wilhelmson 2012), have been developed.

Even though there are several options available for ecological sanitation facilities, a wide scale emergence of dry toilets has yet to be seen. The design of a toilet is very important: a good toilet is user-friendly, easy to maintain, odourless, does not block or break easily and is convenient to use. (Ulrich & Deegener 2012.) Naturally, the qualities required of a toilet depend on the user as well as the using environment; most of the value is given to the users' experience and preference to emphasise ownership.

Overall, dozens of ecosan models have been developed to fit a certain environment or culture. Some of these models work better than others, but there is a continuous development in the technology available (see, e.g. GDTA 2012; Panesar *et al.* 2010). From outdoor pit latrines and long drops, the development has moved on to porcelain indoor dry toilets without any flies or odours (Engström *et al* 2011).

The latest models have also incorporated nanotechnology to ensure the reuse of nutrients (see, e.g. Gates Foundation 2012; Kappel 2012).

Nevertheless, it is still challenging to support the dry toilet as the most efficient option. The sanitation ladder approach can be used for measuring the development of sanitation facilities from open defecation to unimproved facilities, and onwards to shared sanitation facility and eventually to improved sanitation, the latter including pour/flush toilets with a piped sewage system or septic tank, VIP latrine or composting toilet (UNICEF 2008b; JMP 2010). This approach measures the development towards more improved sanitation facilities, but until recently did not include an ecosan option: composting toilets were added to the list of improved sanitation facilities only in 2006. Still, the ladder, as well as the global norms – the sanitation institution – indicate that waterborne sanitation is the most desirable option. New suggestions for a more function-based sanitation ladder have been made, so the ecological aspects such as nutrient recycle and clean water management could be taken into account better. (Kvarnström *et al.* 2011.)

4.4 Social and cultural sanitation

The third pillar of sustainability is the social aspect, including cultural viewpoints – although in more modern interpretations the cultural pillar has been portrayed as a separate entity. Here, they will be discussed under the same heading because socio-cultural issues are very important when considering sanitation. Issues involving cultural beliefs and customs greatly affect sanitation practices, which in turn have a great impact on public health, education and gender issues. Policymaking and dealing with crisis situations also fall under the social category.

4.4.1 Health and hygiene

One of the major reasons why legislation forbids the use of human-based manure as fertiliser is that there is not enough knowledge on how composted excreta or diverted urine would affect public health. Some bad experiences with the use of (untreated) sludge have led to serious epidemics all over the world, and this is one important, and justified, reason for caution. However, ecological sanitation

emphasises the use of *treated* human waste, and one target of ecosan is to make sanitation *safer*. In fact, several researchers have found that proper treatment of “humanure” and urine can also be done by using ecological sanitation.

Four types of organisms can be found in wastewater and excreta: viruses, bacteria, protozoa and helminth (parasitic worm) eggs. Out of these four, it is mainly the helminths which cause issues in sanitation; the other organisms are well-known and can be dealt with more easily. The helminths are transmitted through consumption of contaminated water and irrigated crops. Up to 10 % of the population of developing countries is estimated to be infected with this parasite. A simple prevention method, in addition to wastewater treatment, is adequate hygiene, as the contamination can occur through the oral faecal route. Helminth eggs are resistant to several environmental conditions, but can be inactivated by high (>40°C) temperatures. This suggests that a proper composting process, where temperature is around 60°C over a sufficient time period, is enough to destroy the parasites. (Jiménez 2009.) Microbes can be destroyed in a relatively short time, but in order to achieve proper safety a composting period of at least a year is recommended. This is to make sure that the temperature remains high enough during the entire process, because especially viruses and some parasite eggs can survive in cooler conditions for several weeks, or even a year. (Austin 2002.)

Studies conducted in several countries, such as Bangladesh, Sri Lanka, India, Nepal and Ghana, indicate that use of urine fertiliser in vegetable production is both efficient as well as quite safe (Pradhan *et al.* 2012; Pradhan & Heinonen-Tanski 2010.) Similar studies conducted in Finland have arrived at the same conclusion regarding the efficiency and safety of human-based fertiliser. Diverted urine and composted excreta have been used on lettuce, cucumber and other vegetables, yielding some good results. (Shrestha *et al.* 2013; Viskari *et al.* 2012; Mnkeni *et al.* 2008; Guzha *et al.* 2005; Heinonen-Tanski *et al.* 2005.)

It is not only the microbiological risks of urine and excreta fertiliser that has been examined, nor the efficiency and user-friendliness of the product. Also the additional components of urine might be a risk to health. Fertilisers are usually tested for traces of heavy metals and human-originated fertiliser is no exception. According to studies, neither lead nor mercury are taken up to any extent by crops and consequently do not pose a risk through the dietary intake of plants. Cadmium, however, can pose a threat as it can accumulate in crops. In practice, though, it has

been found that humans are protected from cadmium toxicity because the high ratio of zinc to cadmium in sludge inhibits the uptake of cadmium in plants, as the prefer zinc to cadmium. In fact, there are no documented cases of human or animal poisoning from excess cadmium intake from plants. Copper, nickel and zinc can be translocated to the edible parts of crops; however, here the protective method is the so-called soil-plant barrier, stunting the plant growth before potentially harmful levels are reached. No adverse human acute or chronic toxicity effects have been reported from the ingestion of food plants grown in sludge fertilised soils. (NZWWA 2003.)

Studies on the impact of most common hormones and pharmaceuticals found in urine fertiliser have been conducted on some level – and research is still ongoing. So far it cannot be said that hormones or pharmaceuticals could have any impact on crops, but their effect on aquatic ecosystems is still being determined. Eliminating pathogens and odour control are other issues being tackled by recent studies. (Winker 2009; Pynnönen & Tuhkanen 2012; Viskari *et al.* 2012.)

Methods on how to eliminate parasite eggs in faecal matter is yet another point to focus on. It has been found that sufficient temperature (70 Celsius degrees) for at least one hour is enough to eliminate most parasite eggs and other microbes – the challenge is to maintain such conditions reliably. (Itchon *et al.* 2012.) Furthermore, it has been found that composting (among other methods) is enough for treating sewage sludge for agricultural purposes, as soil hygiene is weakened by sludge products only slightly, if at all (Tontti 2012). Even though more research is required, so far it has been stated that if the composting time, pH and temperature are as required, ecological sanitation can be as effective as conventional wastewater treatment, or even superior to that. Also the guidelines provided by WHO (2006) support these claims as they proclaim ecological sanitation a safe and hygienic option if all the said requirements are met, including watertight containers and hygienic conditions with hand-washing opportunity. (Gajurel & Wendland 2007.)

4.4.2 Agricultural practices and fertiliser use

Several case studies have been conducted globally to determine the feasibility of human excreta and urine as fertiliser. Generally, it has been found that it depends on

the type of plant as to whether urine makes a significant difference compared to the use of artificial fertiliser. The results find that properly managed and source-separated human excreta is a safe and sustainable fertiliser in food production. Pathogens were not found in significant amounts and their origin can be other than the fertiliser product used; mycobacteria, for instance, have been found to survive only a maximum of 1-2 months. Especially the composting process increases the inactivation rates of pathogens. (See, e.g. Viskari *et al.* 2009 and 2012; Pradhan 2010; Orumwense *et al.* 2012; Sossou *et al.* 2012; Srinivasamurthy *et al.* 2012.)

An issue is also presented by pharmaceuticals and hormones which are excreted via urine and do not show good biodegradability, as in recent studies they have been found in wastewater and freshwater. At the moment there is not enough information about the behaviour and accumulation of these substances in crops when urine is used as fertiliser. Ibuprofen, for instance, has been found to degrade in soil relatively quickly, but many others, especially veterinary pharmaceuticals, could be found for a longer period of time. Hormones, such as estrogen, have been studied but no conclusive results yielded so far. Also traces of anti-malarial drugs have been studied in agricultural soil where human urine has been used. Although evidence suggests that the substances do not affect the crops, it is still too early to draw any conclusions. Micro-pollutants have been detected in aquatic environments, as well as in soils irrigated with wastewater. Thus, there is a risk that edible plants might also be contaminated and potentially cause harm to human health. More knowledge on the negative effects of pharmaceuticals and hormones is required. A possible solution would be to concentrate on developing biodegradable pharmaceutical substances, but this does not seem feasible. (See, e.g. Behrendt *et al.* 2009; Liu *et al.* 2009; Viskari *et al.* 2012; Miyai *et al.* 2012; Pynnönen & Tuhkanen 2012; Writer *et al.* 2013.)

Several goals have been set for reducing waste and recycling it as much as possible, but no concrete targets for recycling nutrients have been set. However several policies target avoiding nutrients leaching out to ground water, lakes, rivers and oceans. (Ministry of Agriculture and Forestry 2011.) The European Community produces up to 8 million tonnes dry weight of sludge a year. Of this, approximately 40 % is applied to agricultural land, 6 % to forest and the rest is disposed of – often by incineration or even dumping in landfills. The US produces about 5.5 million tonnes dry weight of sludge per year, of which about 40 % is applied to land

(agricultural or domestic/public gardens) and the rest is disposed of in landfills (17 %), by incineration (22 %) or other methods (21 %). In Australia, out of about 300 000 tonnes dry weight of sludge per year, up to 90 % is beneficially used in agriculture (pastoral, cropping and forestry) of which 25 % goes to the domestic market via composting. (NZWWA 2003.)

Nevertheless, the application of human-originated nutrients on land is not without controversy. In parts of the US, for instance, there have been consumer-led boycotts of the products grown in human-based fertilised fields, and some countries prohibit the application of this practice for a variety of reasons. (NZWWA 2003.)

4.4.3 Cultural traditions

As pointed out in the sections above, human beings instinctively avoid foul odours, dirty water and excreta. This has been taught to us thousands of years ago: foulness causes disease. These teachings can be found in stories and holy texts, and are also imprinted in the customs of various cultures. (Vuorinen 2007; Douglas 2002.) Islamic culture, for instance, has clear rules for toilet behaviour, and the Koran emphasises the need for hand-washing after going to the toilet (Koran, verse 5:6). An example of Islamic toilet rituals can be found in the following.

Whenever the Prophet went to answer the call of nature, he used to say, "Allah-umma inni a'udhu bika minal khubuthi wal khaba'ith i.e. O Allah, I seek refuge with you from all offensive and wicked things (evil deeds and evil spirits)." (Sahih Bukhari 1:4:144)

It is important to wash after relieving oneself, and human excreta is considered a taboo. The washing practice is common especially in Muslim cultures and in certain parts of Asia, which, however, still does not pose an obstacle to dry sanitation (especially the urine diverting toilet). (Schönning & Stenström 2004.)

Toilet behaviour is indeed instructed also in several religions. In the Christian Bible, the 5th Book of Moses gives guidance on excreta handling:

“Thou shalt have a place also without the camp, whither thou shalt go forth abroad: and thou shalt have a paddle among thy weapons; and it shall be, when thou sittest down abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee:” (Deuteronomy 23:12-13.)

The Hindu culture deems left hand unclean, as it is used for toilet purposes. Similar cultural habits spell the protocol for using the toilet. Where people of varying social status are valued differently, there are strict rules on who can clean and empty a toilet, who can use the same toilet (often the divide is male vs. female), and whether one should sit or squat. (Shrestha 2012; Huuhtanen & Laukkanen 2009.) These behaviour models have often started from certain ancient health and safety guidelines, but have since begun to support the imbalance of power within communities, based on the ruling sex, ethnicity or cast. (Douglas 2002.)

The cultural practices might also have a strong say in the fertiliser use of human excreta. Human waste is known to be “filthy”, which is why it should be stored away from food. It is, in fact, these prejudices towards composting and dry toilets which make it challenging to promote ecological sanitation. In some cultures it is a taboo to even talk about the toilet, which in turn makes the process even more difficult. In these cases, education plays a critical role, as well as participatory practices, such as Community Led Total Sanitation (CLTS). (Huuhtanen & Laukkanen 2009; Kar 2012.)

Issues that become key factors in sanitation development are the same basic matters in every culture: hygiene education and understanding the link between lack of hygiene and sickness is the first to bring about the need for adequate sanitation. Once the need for a toilet has been established, it becomes a matter of affordability, user friendliness and social status (Kaminsky & Javernick-Will 2014). A toilet can be a large investment for the poor but ecological sanitation can offer an incentive in the form of free fertiliser.

Subsidies can help, but experts have different opinions on their benefit. According to some, subsidies may lead to lack of ownership and thus sanitation facilities are not properly maintained. Some approaches, such as Community Led Total Sanitation (CLTS), rely more on behavioural change from within communities rather than bringing along outside assistance. Some projects rely on subsidising

some key construction materials, while most of the labour and other costs are paid by communities. (Kar 2012.)

Education plays a key role in sanitation. Without adequate sanitation, especially girls tend to leave school once they reach puberty, which in turn has other impacts on the entire society. Proper sanitation facilities at school also teach about hygiene and sanitary practices from a young age, and these practices also tend to rub off at home. Some schools also teach farming and include ecological sanitation with proper handling of urine and faeces, so that the children understand the natural cycle of nutrients. (Wendland *et al.* 2012.)

Even though cultural traditions may cause prejudice and opposition towards dry sanitation and using human excreta as fertiliser, there have been several studies indicating that people are, in general, ready to accept ecological sanitation or dry toilets. Studies indicate that even though urine diverting dry toilets (and other ecological sanitation practices) might be unfamiliar to many people, it can be seen that many are still positive or neutral regarding such sanitation facilities, despite being from Western economies, Muslim culture or developing countries. Practices such as using dry sanitation facilities and using compost or urine as fertiliser have received relatively positive feedback. (E.g. Paz *et al.* 2012; Lamicchane & Babcock 2013; Uddin *et al.* 2014; Maennel 2014.)

4.4.4 Gender and equality

Sanitation, being a very private matter in some cultures, can be difficult to address, let alone when one suggests growing one's food by using toilet waste as fertiliser. However, sanitation has finally been included as a basic human right by the UN (United Nations 2010; WHO 2012), which could suggest that the topic is slowly becoming more visible all over the world. It is, in fact, a very important part in achieving equality between gender as well as different nations.

Several research projects in various countries have shown that local ownership, participation and empowerment of especially women are important factors when bringing forth a new method of sanitation – and farming crops. Several researchers have found that in cultures where women are in charge of taking care of the home and, for instance, fetching water, their decision on what kind of toilet is suitable for

them is often the key. (See, e.g. Shrestha 2012; Rehema Bavuma 2012; Farhat 2012.)

Women are most affected by inadequate sanitation. There is often a sense of shame related to toilet visits, especially for women, which is why they have to relieve themselves at night, thus being vulnerable to attacks by rapists or wild animals. (UNICEF 2010a; IBP 2011; UNHR 2011.) This sense of insecurity often causes girls to leave school once they start menstruating, as schools often have insufficient toilets. Girls often refrain from drinking during the day, which can cause other problems, and avoiding going to the toilet can also cause constipation. (Dankelman *et al.* 2009; UNHR 2011.)

Sanitation hygiene is also more important for women. It is natural for women to have the need to urinate more frequently, and holding it in as well as unhygienic circumstances may cause urinary tract infections. Especially when menstruating, hygiene is important, while in some communities women are considered impure at the time and may not use common facilities. (Fisher 2006; WECF 2012.) In some cultures, going to the toilet and menstruating are causes of shame for women, which makes their life more difficult. Women also face the importance of hygiene during pregnancy and nursing. If transmittance of disease were known to women, infant mortality would be much lower; many infants die of diarrhoea and other disease spread by contaminated water and food – even the mother's touch. (UNICEF 2009.)

However, women are often the ones in charge of hygiene and sanitation in their communities, as they are most affected by it. Fetching water is a woman's task, as it is to take care of children and cook food, etc. It is important that women teach their children hygienic and safe practices, as children learn from them. (Fisher 2006.) The situation becomes challenging if women are not allowed to take part in planning processes when sanitation facilities are constructed; the best results are gained when the people using and maintaining the facilities are part of the process from the beginning. Sometimes hierarchical and patriarchal practices prevent female participation, although they are the ones who end up with the maintenance. Flush toilets are not always a solution for women, who must fetch water in order to use the toilet, which, in turn, can be humiliating. (Huuhtanen & Laukkanen 2006.) Women are ultimately the ones who have impact on the hygiene behaviour of the entire community, so their views should be taken into account.

So far there are unequal roles in sanitation between men and women, but also between various societal classes. The poor are less likely to have access to proper toilets, which means they cannot participate in social events as much since they are limited by their physical needs to defecate and urinate close to home or only at night. Sanitation is equality. (Dankelman *et al.* 2009.)

Solutions to make sanitation more equal towards women are quite simple. The toilet facility should be near the house with a non-visible entrance so no shame can be caused by seeing someone entering or exiting the toilet. It should be easily cleaned and not use much – or preferably at all – water. Ideally, tasks such as cleaning and emptying the toilet should be divided between family/community members.

Overall, it is a matter of behavioural change. Attitudes must compliment the practices and these must be supported by policies. Political decisions on housing, water supply and sanitation, as well as agriculture, shape the system in which ecological sanitation can fit in the picture. If human-based fertilisers are forbidden by law, it is challenging to endorse their use; if it is compulsory to join the sewage network it might not be as convenient to get a dry toilet instead.

4.4.5 Education

As mentioned above, education plays a key role in breaking patterns, changing attitudes and moulding new behaviour models. Especially children, who are also the most vulnerable to infections, parasites and other disease, can be influenced at school. It has also been studied that an increase in literacy rates (especially female literacy) reduces child mortality; this also encourages teaching women and children how to read. (SIWI 2005; Bartram & Platt 2010.)

Education also brings new aspects to old habits. Knowledge on viruses, bacteria and parasites, and how they spread, may help people to understand why some things are forbidden or why people fall ill. But at the same time, there is the benefit of understanding the cause and effect, and in time also irrational beliefs may bend under the weight of knowledge. Knowledge, especially concentrating on female education, has proven useful in improving the position of women in communities. This, in some instances, has resulted in more free thought patterns, where women

and men can use the same toilet facilities. (Huuhtanen & Laukkanen 2009.) It is to be noted that toilet culture is a sensitive topic in most cultures, and that old habits die hard also in the Western worldview.

Teaching people especially about safe hygiene practices is the key, but sanitation means much more to education. It has been evaluated that women staying at school instead of dropping out (and, as mentioned, one important reason for quitting school is lack of toilets, especially once puberty starts) has numerous societal benefits. It has been argued (e.g. Gore 1994) that increased female literacy rates are linked to higher female employment rates and also lower amount of children per woman due to knowledge of contraception and career plans. In addition, once children stay healthier, there is not as pressing a need for families to have several children, as infant mortality is lower. This, in turn, leads to lower population growth and healthier people.

4.4.6 Emergency sanitation

Sanitation is vital in everyday life, but it is often taken for granted. The dire need arises in the wake of a crisis, when no running water or electricity is available, or when living conditions are unstable for one reason or another. Earthquakes, floods or conflict situations present scenarios where sanitation is necessary yet inaccessible.

In addition to permanent sanitation structures, it is necessary to develop facilities that can be used when the sewage network is not functioning or power is down. Several projects in disaster areas, such as earthquake-ridden Haiti, have succeeded in developing composting toilets which respond to the need of the inhabitants. In conditions where disease spreads fast due to unclean drinking water and inadequate sanitation, dry toilets can be used in both rural and urban areas. The structures can be used also in “normal” times, as the facilities are a good match with waterborne sanitation which does not take into account the needs in crisis situations. (Larsen & Koestler 2012; Jenkins 2012.)

Unfortunately, sanitation can be the last thing considered when planning aid to a crisis area. Yet the need for sanitation does not wait and it is necessary to have facilities which function in the worst cases. Dry toilets have proven useful also in

urban crises, where infrastructure or state do not support improved sanitation. (Patinet 2012.) Dry toilets can be considered useful when adapting to climate change: increased floods, droughts and other unpredictable events may cause problems with access to drinking water or use of toilets (Mahato & Ingle 2012). Ecological sanitation can provide an option for these occasions, and why should it not be an option after the crisis, too?

In fact, there is a need for functional dry toilets which are easy to transport and maintain to help disaster areas – and these solutions are being developed. Chapter 5 gives an example from New Zealand, where a dry toilet trial for earthquake preparation has yielded positive results.

4.5 Reality check

After this brief clarification of what ecological sanitation is and how it could solve the world's phosphorus crisis as well as the sanitation problem with only positive impacts on the environment, one question remains. Why are we not implementing this technology? The reasons are many, as none of them really explains the situation fully.

Firstly, as has been pointed out earlier, humans tend to instinctively react negatively towards their own waste - this is a protective mechanism to protect us from infectious disease. Now, when asked to put human waste on the field where your food is grown, many people find this revolting. It does not matter if the waste has been treated or composted, that it is hygienic and clean - once something has become waste, it will always maintain the stigma. One of the main challenges in achieving the closed cycle is the attitudes humans have. Waste is something that has been discarded and is better left alone – using it for any other purpose, let alone growing food, is a strange thought indeed. (Douglas 2002.) This is one reason why excreta should not be referred to as waste - let us regard it rather as product.

The next step would be to consider how human attitudes can be altered. General rules of society are important here, which is why legislation on ecological sanitation would be important to support these practices. However, most countries do not consider human waste – or even dry toilets – in any way in their legislation. The use of animal manure is being discussed but humanure is either not mentioned, or banned altogether.

Whether or not legislation is for or against the practice, hardly anything will be done unless it is easy or profitable. In developed countries, where sewage networks already exist in major parts of the inhabited regions, there is no incentive to choose a method where one would have to empty one's own latrine onto one's own garden – not to mention the people without their own reuse possibilities. A service would have to be offered, but this will not happen without the demand – which represents a vicious circle. Another challenge is presented by peri-urban settlements or slums of the developing world, where there are no gardens or services. The waste, or product, must be disposed of somewhere, and since the source is unlimited there must be an on-going, reliable service.

Farmers would probably welcome the product quite happily, assuming they could continue selling their products as usual (Muskolus & Ellmer 2007). Yet there are so many different actors in the equation in order for it to work that careful planning and determined implementation are required. Multi-sectoral policies and multidisciplinary approaches taking into account users, policy-makers, service providers, consumers and farmers – to name but a few – are the only way to make sustainable sanitation a mainstream reality.

Often, political will and policy-making are the dragging points. Based on the GLAAS2012 report by WHO and UN Water (WHO 2012), which includes data from 74 developing countries struggling with sanitation, a growing number of states have already separate sanitation policies drafted or implemented, with 63% and 77% of responding countries having adopted and published policies for sanitation and drinking water, respectively. Yet it is not just about the policies but also the implementation. Many countries report not having enough information for effective investment planning or resources for follow-up, with decentralisation policies implemented in over 90 % of the developing countries. The problem is that fiscal decentralisation level accompanied only 40 % of the countries surveyed. (WHO 2012.) As for industrialised countries where sanitation policies are in place, the question is about the implementation of ecological sanitation, which often depends on strict legislation.

The World Health Organization has released Guidelines for the Safe Use of Wastewater, Excreta and Greywater (WHO 2006), which discusses the health and safety issues of the use of human waste as fertiliser. The guidelines provide the minimum requirements of good practice to ensure hygienic use of urine and faecal matter. The main issues include the safe storage time for dry excreta, faecal sludge and

urine, and composting fits under these guidelines. However, the WHO guidelines do not necessarily guide national legislation.

The EU, for instance, has set strict directives on the use of sewage sludge in agriculture. However, the terminology does not cover ecological sanitation, i.e. diverted urine and composted faeces. Basically, it can be interpreted that the agricultural reuse does not conflict with the EU legislation concerning sewage sludge. (Richert Stintzing 2007.) Still, there are strict restrictions on when and where sewage sludge can be used - in Switzerland sewage sludge is prohibited on any arable land (Cohen *et al.* 2011). The main reason for strict legislation is the potential risk to public health. Yet it has been forgotten that composted faeces and diverted urine behave much differently from sewage sludge, as they have no industrial waste or other extra components in them.

This chapter has presented ideas, thoughts and 'whatifs' but the concrete aspect has been limited. In the following, some cases from developed and developing economies will be examined in order to understand the feasibility of the ecological sanitation approach.

Our rituals of cleansing and disposal are enfolded with this landscape, our personal secrets are implicated in the public secret of sanitation.

– Gay Hawkins, *Down the Drain: Shit and the Politics of Disturbances*

5. The possibilities of ecosan

As described in the previous chapter, ecological sanitation is a complex phenomenon that is affected by many sectors, actors and policies. In this chapter, a closer look is taken at four case countries, where ecosan is being implemented or experimented upon at a certain level. The emphasis is on legislation and policies, although each case deserves its own specific focus. It can be said that it is, in fact, a matter of legislation to support the promotion of safe and sustainable sanitation. Each case country is different concerning the challenges regarding sanitation; however, it can be found that the main factors pushing for or against change towards ecological sanitation are legislation and general attitudes in both people and decision-making bodies. Thus, these countries are observed for the sake of their own unique situation but also in terms of the underlying reasons to promote (or not to promote) ecological sanitation.

Finland, being the country of half a million outhouses and dry toilets, deserves to be the first example. This chapter introduces the Finnish legislation in terms of wastewater treatment and ecosan, and how policies do not always support practices and eager attitudes, as is often the case in Western countries.

The next case is Zambia, where ecosan toilets have been promoted by donors and NGOs, but legislation has not quite caught up with it. Here, we run into the difficulty of lack of political will and resources, as is, again, often the case in developing countries.

The third case study discusses the situation in Ethiopia, where ecosan has been embraced also politically, but resources are lacking to implement a coherent sanitation policy. The problems of developing countries become clear, even though the cases deal with only African countries.

The fourth in-depth case takes us to New Zealand, which is an industrialised country often facing natural disasters such as earthquakes. With a proper sewage system in place, flush toilets become problematic in the case of a natural disaster, which is why a more sustainable toilet is required. This case gives more insight into

how people and government make sense of toilets, or whether they base their judgement on prejudice.

After these cases, a quicker look is taken also at other countries around the globe to determine how sanitation, and specifically ecosan, is portrayed in their culture. Countries from Europe, Asia and the Americas are used as examples. The analysis of the case studies follows in Chapter 7.

5.1 Case Finland

It can be challenging to discover new innovations or even return to the past. There are numerous rules, regulations and standards to take into account, which sometimes seem unjust, unclear or simply insane. It may be difficult to see how laws and regulations have come into being and what motivates the decision-makers to maintain such laws. One example of this confusion is the way legislation deals with an ancient method: the use of human waste as fertiliser. Often the use of “humanure” as fertiliser is not even considered in legislation, or it is banned or limited for hygienic reasons. Generally, the legislation does not differ that much in the developed countries, the EU countries being somewhat similar concerning the content. For clarity’s sake, an example has been made of Finland, which has typical legislation concerning ecosan. This chapter aims to clarify what the status of ecological sanitation is in Finland and, most importantly, why this is the case.

Even though ecosan is seen by many as a solution for the poor in developing countries, there is no reason why it should be disregarded in so-called developed world countries either. In fact, given the facts of expendable phosphorous resources in the world and advanced technology available in industrialised countries, those should be more than interested in developing ecosan solutions. (Bracken *et al.* 2006.)

Finnish people are already accustomed to their “long drops” and outhouses at holiday homes and for the older generation the water closet was somewhat of a luxury item. However, in a few short decades the water closet and drainage replaced the old fashioned dry toilet in the cities, and soon the rural areas followed suit. Meanwhile, synthetic fertilisers replaced manure on the fields, and legislation was quickly updated. Today the Finnish legislature does not consider ecological

sanitation a feasible option for fertiliser use – and in sanitation it is only a secondary option after water-borne lavatories.



Figure 8: Indoor dry toilet, Finland. Photo: GDTA, 2013.

5.1.1 Ecological sanitation and its future prospects in the Finnish legislation

The use of dry toilets is quite common in Finland. Hundreds of thousands of holiday homes in remote rural areas are often outside the sewage network and have their own on-site methods of treating wastewater. The dry toilet is the most common option, as no extra treatment facilities are required when there is no running water. In urban centres, the sewage network is functional and covers most of the population.

The Finnish Constitution states that “[n]ature and its biodiversity, the environment and the national heritage are the responsibility of everyone. The public

authorities shall endeavour to guarantee for everyone the right to a healthy environment and for everyone the possibility to influence the decisions that concern their own living environment”. (Section 20.) Thus, environmental protection is a constitutional duty for the public authorities, as well as the people. As a member of the European Union, Finland also enacts EU directives and regulations on issues such as water policy (Directive 2000/60/EC) and organic production (Council Regulation 834/2007/EC). These EU regulations as well as the Finnish Constitution create the basis for the framework in which the authorities have to operate.

Finland follows EU legislation on the use of sewage sludge for agricultural purposes. Like the EU directives, Finnish legislation does not distinguish the term ecological sanitation. Interpretations on the use of human faeces and urine vary greatly, from following the same guidelines as for animal manure to prohibiting the practice altogether. The owners of dry toilets have been instructed to use their compost and diverted urine in their own gardens but their use on commercial crops is prohibited. (GDTA 2012.) Full-scale use would require careful testing and commercialisation of the fertiliser product, as has been done with sewage sludge (HSY Water Services 2012).

As the legislation on rural wastewater treatment becomes stricter, so people are becoming more interested in the sustainable option of dry toilet and recycling nutrients. The legislation would need to follow this development, but so far it has not shown any signs of change. Furthermore, as more people are using dry toilets, there is a need for logistics and service to transport the waste to be treated further by composting or incineration. Agricultural use of composted faeces requires approximately 20-30 tonnes/ha, equivalent to faeces generated by 2000 - 3000 people as one person produces approximately enough fertiliser to grow food for one individual (Richert Stintzing 2007). If moving into large-scale applications, legislation would have to be more tolerant of the practice.

Finnish legislation includes several acts and decrees which need to be considered when installing a dry toilet and handling human waste. In the following paragraphs, the most important pieces of legislation in terms of ecological sanitation will be briefly introduced.

5.1.2 Legislation on sanitation

There are a number of acts and decrees in the Finnish legislation which define adequate sanitation and the need to treat wastewaters sufficiently before discharging them into nature. These acts are the Environmental Protection Act, the Land Use and Building Act, the Water Act, the Water Services Act, the Waste Act, the Fertiliser Product Act and the Health Protection Act. As the names suggest, these acts deal with environmental and public health matters and sanitation plays only a minor role in each.

The objective of the Environmental Protection Act (86/2000) is to prevent pollution and to promote sustainable use of natural resources – in short, “to safeguard a healthy, pleasant and ecologically diverse and sustainable environment” (Environmental Protection Act 86/2000, §1). Indeed, the act does take into account soil and water contamination (§7-8) but gives guidance on the treatment of household sewage (§18) and wastewater (§103). The act clearly states that soil and water contamination must be avoided to ensure the safety of the environment and public health. However, in respect of sewage the act is less specific. Section 103 on the general duty to treat wastewater requires that household wastewater “shall be drained and treated in such a manner that it poses no threat of pollution”.

However, as has been pointed out, the use of a dry toilet itself is not against the law in Finland; it is only the reuse of the human produce that is being questioned. The addition made to the act in 2011 specifies that only so-called black wastewater from the toilet must be treated, and if no black wastewater is accumulated, small amounts of grey water may be absorbed into the soil. Otherwise, proper treatment to remove phosphorus and nitrogen must be taken care of by the owner of the estate. (Environmental Protection Act 86/2000, §3a; §27b-c.)

The matter of sanitation is also important in terms of land use, as hygiene and a clean environment are important. When constructing a toilet (indoors or outdoors) there are some essential technical requirements of buildings in terms of hygiene, health and the environment, ensuring that no building will adversely affect hygiene because of contamination of water or ground, for instance – building an outhouse or other permanent structure requires a permit (Land Use and Building Decree 1999, §50; §62). Planning of construction as well as land use is crucial in terms of ecological sanitation. Instructions are given on where to build an outhouse, how to

maintain it and how to handle human waste and composts at one's private property – while fertiliser use is not acceptable. The overall demand is to ensure safe and hygienic circumstances so no harm will be caused to public health or the environment. (The Health Protection Act 763/1994.)

The quality of water and its treatment process are specified vaguely: the sewage treatment should be conducted “in an appropriate manner”. The right to be exempted from connection to a wastewater sewer when “there is no damage to health or risk of contaminating the environment” is also mentioned, even though it is generally compulsory to be connected to sewage network whenever possible within the officially defined service area of a water utility (Water Services Act 119/2001, §10-11). Exact parameters are also given for the treatment of wastewater and when the treated water can be discharged into nature. (Government Decree on Urban Wastewater Treatment 888/2006; Waste Act 1072/1993.)

The handling of human produce is not discussed *per se*, even though sustainable development is supported to prevent any harm to health and environment caused by waste. The generator of waste is also responsible for its disposal without endangering health or the environment – for hygienic reasons untreated human waste cannot be added to municipal biowaste. (Waste Act 1072/1993.)

The newly formulated decree on wastewater treatment in rural areas came into force on 15.3.2011. The act states the requirements for household wastewater treatment: whenever there is running or pumped water on the premises, it is necessary to treat the wastewater. Wherever a flush toilet is used, a septic tank or equivalent is necessary, while grey wastewater can be treated through sand filtration. The lighter treatment of wastewater would require the use of a dry toilet, and some later policies do mention the option. (Government Decree on Treating Domestic Wastewater in Areas outside Sewer Networks 209/2011.)

5.1.3 Legislation on agricultural use of human waste

As far as agriculture and the use of human waste as fertiliser is concerned, the legislation offers only one type of approach. Guidelines are given on the conditions when the use of sludge is permitted on cultivated fields. The goal is “to regulate the use of sewage sludge in agriculture in order to prevent harmful impacts on the

environment and health while promoting the appropriate use of sludge” (Government Decision on the Use of Sewage Sludge in Agriculture No. 282 §1). Sludge that may be used as fertiliser in agriculture is to be treated by stabilising the waste by, e.g. digestion, lime stabilisation, composting or other methods often used in wastewater treatment, in order to reduce the pathogen content and odours of the sludge (*ibid.* §4). The sludge may be used only on soil on which crops are not used for human food or animal feed are cultivated, and root vegetables cannot be cultivated in soil fertilised with sludge until five years later (*ibid.* §6). Exact parameters for metals and other trace elements that the sludge may contain are stated carefully. It is to be noted, though, that sludge is wastewater gathered from households, whereas ecosan produces composted faeces and sterile urine separately (if so desired). These matters are not taken into account in the legislation.

However, the use of animal manure and urine are discussed. For the use of animal excreta there are strict rules, and it is possible to use it as fertiliser only during spring and summer, as snow and slush and frost in the winter prevent soil filtration and may cause the nutrients to seep into water courses. Animal manure may be applied on a field as fertiliser equivalent to up to 170 kg/ha/year of nitrogen, which means that the farmer must be aware of the nutrient content of the manure – the same would be the case with human excreta, although this has not been mentioned. (Government Decree on the Restriction of Discharge of Nitrates from Agriculture into Waters 931/2000, §5.)

In terms of fertiliser use, it has been stated “a fertiliser product may not contain harmful substances, products or organisms in such quantities that ... may cause any danger to human or animal health or safety plant health or the environment”. The raw materials of fertiliser products must be safe and such that the fertiliser products manufactured from them fulfil the quality requirements set for them. (The Fertiliser Product Act 539/2006, Section 5.) Again, human-based fertiliser is not mentioned, which leaves some room for interpretation.

5.1.4 Legislation in terms of ecosan

As can be seen based on the extracts from the relevant acts described above, ecological sanitation is hardly mentioned in the Finnish legislation (for more

detailed information, please refer to the translated acts at www.finlex.fi). The acts have been amended with several decrees, and not all of them are discussed above. In terms of sanitation and wastewater treatment facilities, dry toilets are given as one option, but the overall attitude favours the water-based system with a septic tank or some other type of treatment facility onsite. Properly treated or composted sludge can be used in agriculture as fertiliser but it must be carefully tested as a commercial product, which is why the waste from household dry toilets cannot be used in food crop production. Separated urine is not considered as a safe fertiliser for food crops, but can be used privately for lawns and other plants in spring and summer time. Yet urine is practically sterile, especially after a few months' storage period, and safe to use as fertiliser (Pradhan 2010). However, no *conclusive* research has been conducted on traces of drugs and hormones and their effects on human health and the environment.

5.1.5 Ecosan – a feasible option?

As the brief outline on the relevant acts indicates, the term – or even the philosophy of –ecological sanitation does not appear in the Finnish legislation. When it comes to using composted human produce or separated urine as fertiliser, no specific instructions exist. The only clear regulation involves the use of sludge on agricultural fields, but that is limited to the use of crops not intended for human or animal consumption. Furthermore, the parameters for the metal contents of the sludge are carefully indicated in the legislation. It should be remembered, however, that the composted faeces and separated urine are of a quite different nature, as the metal and pathogen contents are relatively low. Also, the handling of the material is more hygienic since the composting process would be completed before the utilisation of the manure.

In order to change the legislation involving the use of human produce as fertiliser on a wider scale, it is necessary to change the attitudes to begin with. There are already a number of research papers written on the suitability of composted faeces and urine as fertiliser (e.g. Drechsel *et al.* 2010; Pradhan 2010; Viskari 2009), and the results have been quite encouraging. With a thorough composting process and proper handling, the soil and the urine are safe to handle and to use even on plants

meant for human consumption. The main issue seems to be the general attitudes towards excreta and lack of knowledge concerning composting and urine characteristics.

The vast amounts of research conducted worldwide ought to act as proof that this ancient method of treating human waste is most sustainable: efficient and ecological. Artificial inorganic fertilisers of nitrogen and phosphorus, among others, can cause infertility in soil – especially when used for long periods of time – and this has caused problems mainly in poorer countries in terms of soil degradation as well as farmers becoming dependent on costly artificial fertiliser. Furthermore, it has been estimated that phosphorus will be available for only another hundred years, and even today the mining of phosphorus has become increasingly challenging. (Viskari 2009.) This has the potential to cause serious problems in food production unless an alternative for phosphorus is found. Even the Ministry of Agriculture and Forestry has examined the possibility of Finland becoming a leading country in nutrient recycling. Unfortunately, the report does not consider ecological sanitation as one option for nutrient recycling, but concentrates rather on cattle manure, sludge management, reuse of bio waste and nutrient collection from water bodies. (Ministry of Agriculture and Forestry 2011.) The important aspect of efficient reuse of so-called “pure” human waste has hardly been discussed.

Although new ideas should be welcomed in the discussion, changing the legislation itself is a long process, and it requires motivation and knowledge from those who are involved. As can be seen from the recent discussion in the media raised by the decree on wastewater treatment in rural areas, support from the people is required for the implementation of a new law. Instead of political debate, actual information ought to be spread around to help people make their own decisions.

5.1.6 The “Finnishing” touches

This chapter has introduced the pieces of Finnish legislation which deal with sanitation and the recycling of nutrients. Even though ecological and sustainable methods are supported by the Environmental Protection Act, the Waste Act and many others, the reuse of human produce has been made almost impossible. This paper also has explained the positive impact that ecological sanitation could have on

the environment, agriculture and human health. However, the process of changing legislation is long and political will is required in order for a change to take place. It is necessary to study the process of decision-making in order to understand what is limiting the use of ecosan on a nationwide scale. The opposing arguments concerning health and hygiene have been countered on several occasions. The process starts from policies, and so far the ministries have not indicated any interest in developing dry sanitation in Finland. It can be assumed that legislation will not be amended as long as the general attitudes towards dry sanitation remain negative or indifferent.

It must be noted that Finland acted as an example in this case. However, many characteristics typical of developed country legislation are present in the case of Finland. Furthermore, also the EU directives guide the development of legislation of both Finland as well as other member countries. Thus, the conclusions can be applied to a variety of countries, bearing in mind not to over-generalise matters. On the other hand, as far as developing countries are concerned, they rarely have any concept of dry or ecological sanitation, as they are trying to control the already poor sanitation situation they are facing. Ecosan could be a solution for them, too, and policy can be used as a tool to guide the change towards the desired direction. Still, many of the global decisions and policies are based on the same aspects, and a change must start from countries which can afford it.

5.2 Case Zambia²

This chapter examines the status of ecological sanitation in Zambian legislation and its effects in practice. In order to understand the sanitary aspects of Zambian legislation, one has to understand first a) the current situation in Zambia regarding sanitation, and b) how and by whom the legislative system operates. Eventually, effective implementation of legislation culminates in the successful enforcement of law in practice. This chapter aims to determine the relationship between the Zambian policies and the actual practices involving ecosan, examining both

² This chapter is based on O'Neill (2011), The Role of Legislation and Policies in Promoting Ecological Sanitation. Case Zambia. In Lakkala. & Vehmas, Trends and Future of Sustainable Development, pp. 147-158. Finland Futures Research Centre, Turku.

sanitation and irrigation aspects. Through the scrutiny of legislation and policies the aim is to learn how the written documents and strategies conform to the actual practices.



Figure 9: Hygiene education in Lusaka, Zambia. Photo: GDTA/Huuhtanen S (2013).

Ecological sanitation is a viable option for improved sanitation. However, to ensure the full benefits of the system, the use of human excreta must be allowed as fertiliser. In this paper the situation in Zambia is described: could ecosan be a potential solution for the country's sanitation problems, and how does the legislation enforce this? The areas studied here vary from legislation on housing and public health to environment and agriculture – to ensure the legality of ecosan and the reuse of nutrients in all aspects of society. However, it is challenging to maintain a common line of policy in all the sectors, and often it is possible to see a notable difference in the motives of authorities, which leads to a continuing cycle of debate and conflict.

5.2.1 Sanitation in Zambia

The sanitation situation in Zambia remains poor. Especially in the peri-urban areas in the outskirts of towns, where the population is rather dense, it is difficult to organise proper sanitary facilities. Sewage infrastructure does not reach the outskirts

and renovations would require additional investments: something the country simply does not have the resources for. Traditional pit latrines are the main sanitary facility, but a high water table and heavy rains in the rainy season increase the risk of polluting the groundwater and thus enable the spreading of diarrhoeal diseases such as cholera causing epidemics nearly annually.

These figures, however, do not take into account the definition of improved sanitation. Improved sanitation, by definition in the National Rural Water Supply and Sanitation Programme (NRWSSP) of 2007 includes ventilated improved pit (VIP) latrine, a pit latrine with a sanitation platform, a traditional pit latrine with a smooth floor surface, an ecosan latrine, a flush/pour-flush latrine and a septic tank latrine (Republic of Zambia 2008). However, the figures from the Central Statistics Office (2006) are based only on VIP latrines and flush toilets. The lack of clear definition makes measurement difficult. The figures used here are based on the Zambian Health survey of 2007, which defines adequate sanitation as follows:

“A household is classified as having an improved toilet if the toilet is used only by members of one household (i.e., it is not shared) and if the facility used by the household separates the waste from human contact.” (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2004)

According to the survey, 43.7 % of the urban population and only 12.9 % of the rural population had access to an improved sanitation facility, bringing the total to 23.9 % of the Zambian population having adequate sanitary facilities. Most toilet facilities were flush/pour flush toilets or improved pit latrines – composting toilets amounted to only 0.1 % in urban areas. As many as 23.5 % of the population have no sanitation facilities of any kind, with the percentage being 1.8 % and 35.4% in urban and rural areas, respectively.³ (CSO *et al.* 24, 2009). Improving sanitation conditions is one of the millennium development goals, but so far the target seems out of reach. The annual growth rate was 2.3 % in 2000-2008, and with a total population of 12.6 million it means many more people without adequate sanitary

³ Due to unclear definitions, the figures differ radically. Here, I have chosen to use the latest Zambian figures. For comparison, the figures from UNICEF indicate that 52 % of the population use improved sanitation facilities, with the urban and rural sanitation coverage being 55 % and 51 % respectively (data from 2006).

facilities. Another threat to sanitation is the growth of the urban population, which usually indicates an increase in inhabitants of peri-urban areas. In 2000-2008, the growth rate of the urban population was 2.5 %. In 2008, the urbanisation rate was 35%. (UNICEF 2010b.) According to statistics, composting toilets only account for 0.1 % of the latrines in urban households in Zambia (CSO *et al.* 24, 2009).

Inadequate sanitation causes the spread of diseases such as cholera and dysentery. Contaminated water and unhygienic disposal of excreta increase exposure. The under-five mortality rate in Zambia is one of the highest in the world at 148/1000 live births, and diarrhoea accounts for approximately 1/5 of all deaths among infants. (UNICEF 2008a.)

5.2.2 Ecosan in practice

Traditionally, human waste has been used as fertiliser in Zambia, and although it is not widely discussed, informally the method is accepted. Especially poor farmers who cannot afford to buy inorganic fertiliser often buy and sell human manure as fertiliser. People in peri-urban areas are known to take their irrigation water illegally from sewage lines, which has been found beneficial for the growth of vegetables. (ECZ 2010; Lusaka City Council 2010.) However, if not treated properly, human waste can be a serious threat to public health.

In general, dry toilets and recycling of nutrients is already a reality in Zambia. Human waste has been used as fertiliser as a standard procedure even with old fashioned pit latrines. The increasing amount of ecosan projects has created a growing interest towards urine separating dry toilets and the use of plain urine in small scale irrigation. It is reported by several authorities that it is difficult to have an open discussion of sanitation due to cultural issues – it is considered to be a private matter. Incidentally, handling human waste has traditionally been work for the poor and the mad, so utilising the product becomes a problem. (MLGH 2010.)

Even though unhygienic pit latrines are technically not allowed, the local authorities have no option but to accept them due to various reasons, such as lack of resources. It is not possible to provide sewage connection to all areas, and even proper latrine construction can prove to be too expensive for the people. (Lusaka City Council 2010.) This is why ecosan would be a suitable option for providing

sanitation to even densely populated and remote areas. However, the lack of information presents one of the major challenges. Indeed, ecosan could be one acceptable and recommended sanitation method, but because of lack of knowledge, the authorities do not see any reason to promote it. Furthermore, legislation cannot be changed to promote dry toilets until some authority is willing to start work on the process. So far, the benefits of ecosan are known by individuals, but the units responsible are not convinced enough to start working on a policy or a strategy on ecosan. (MoH 2008.) The result is a cycle of recommendation leading to proposal, only then being cancelled by an existing motion. The political priorities are often limited to one single sector and multidisciplinary planning is forgotten. (Ascher & Healy 1990; Brands 2014). This stationary movement which appears like development can be recognised from the conflicting laws and policies present in Zambian society – as described below.

5.2.3 Legislative system in Zambia

The legislative system in Zambia revolves around separate administrative and governmental bodies. The Parliament, responsible for enacting legislation, consists of the National Assembly and the president, both elected by the people for 5 year terms. The unicameral National Assembly has 150 parliamentary representatives, who stand for election and eight are nominated by the president, as well as the speaker. (State House 2009.)

To oversee government administration and subject its activities to scrutiny on behalf of the electorate, the Parliament has established parliamentary committees that conduct surveillance on defined areas of government administration. A parliamentary committee system enables Parliament to probe into any maladministration and make recommendations for improvement. (National Assembly of Zambia 2010.)

When a change in an act is to be initiated, local authorities, along with the relevant ministries and authorities, start doing the groundwork. In the case of ecological sanitation, the main responsibility would lie with the Environmental Council of Zambia (ECZ) and the National Water and Sanitation Council (NWASCO). Together with Ministry of Local Government and Housing (MLGH),

Ministry of Health (MoH), Ministry of Energy and Water Development (MEWD) and Ministry of Tourism and Environment and Natural Resources (MTENR) they would complete stakeholder analysis and collect comments from the public – all the preliminary work needed to initiate a change in legislation. (ECZ 2010.)

The draft, prepared by these authorities, is presented to the Parliament for the first reading, after which the bills are referred to relevant committees. The committee hears selected experts and calls upon presentations from institutions and NGOs. Eventually, they determine which act is to be changed and in what way. (National Assembly of Zambia 2010.)

The Parliament enacts legislation through bills passed by the National Assembly and assented to by the president. Any member of the National Assembly may introduce bills in the Assembly. Once a bill has been submitted to the president, it must be assented to within 21 days by the president or referred back to the speaker for reconsideration. Every citizen has the right to petition Parliament to enact, amend or repeal any legislation, as well as the right to comment on discussion and debate at the Parliament. (Constitution of Zambia Act 1991; Interpretation and General Provisions Act 1994.) If an issue does not require an official enactment of Parliament, simple regulations can be put into force by decisions of the relevant ministry (ECZ 2010). In addition to Parliament being able to change or create acts, also the local authorities can make by-laws for “the good rule and government of its area”. The by-laws are confirmed by a minister. (Local Government Act 1991.)

5.2.4 Legislation on ecosan

The issues involving sanitation, ecological sanitation and recycling of nutrients are spread over a rather wide area of legislation, from housing to public health, water and agriculture. The most important pieces of legislation are briefly described in the following.

The Local Government Act of 1991 obligates the local authorities to establish and maintain sanitary convenience and ablution facilities as well as provide a clean water supply and prevent the pollution of water courses. However, sanitary facilities are limited to “drains, sewers and works for the disposal of sewerage and refuse”, and while the act is not limited to that definition, no other definitions are specifically

mentioned. Furthermore, in terms of agriculture, the councils are required to take measures for the prevention of soil erosion, including the prohibition and control of cultivation. (Local Government Act 1991.)

The Public Health Act (1995) deals systematically with sanitation in its section Sanitation and Housing. The act states that no nuisances are to be tolerated, the nuisances including any type of latrine or a deposit of refuse or manure, which could be dangerous to health. The local authorities are in charge of supervision and preventing these nuisances from occurring. In addition, the Public Health (Infectious Diseases) Regulation states that “no person shall permit any manure or garbage on his premises or land, so as to be a nuisance or dangerous to health by affording facilities for breeding by flies or other insects”. (Public Health Act 1995.)

Section 75 of the Public Health Act, The Public Health (Drainage and Latrine) Regulations, strongly prefers the water closet as the type of latrine. In fact, an owner of a non-water closet can be asked to replace their latrine with a water closet. More primitive "pail closet" (latrine accommodation including a movable receptacle for human excreta) and "pit closet" (latrine accommodation situated over any hole or excavation in the ground) are allowed only in exceptional cases, and a permit from a local authority is always required. A dry toilet is not at all allowed within a dwelling house. (Public Health Act 1995.)

If a dry latrine is erected, hygiene is an important factor, and the builder must ensure by using “all reasonably practical measures” that no flies gain access to the apartment. A pail closet must not be less than 3 meters from any kitchen nor in a position where it could cause annoyance to neighbours. The design must be as approved by local authorities. Pit latrines, on the other hand, are forbidden. (Public Health Act 1995.)

The Water Supply and Sanitation Act of 1997 is merely for establishing the National Water and Sanitation Council (NWASCO) and defining its duties. While the council’s task is to act as an advisor to both the government as well as commercial utilities and other actors, they are responsible for establishing and enforcing standards for sanitation and developing guidelines for the sector. They are in charge of issuing operating licenses to commercial utilities, and thus monitor that the sanitation services are given according to the existing laws and regulations of Zambia. (Water Supply and Sanitation Act 1997.)

The Water Act, on the other hand, mainly concentrates on the ownership and user rights of water bodies. Pollution is forbidden but the details are vague (Water Act 1994). However, the renewed Water Act was under revision by the Parliament in 2011.

The Environmental Protection and Pollution Control (amendment) Act of 1999 discusses the use of any effluent, but limits the definition to all agricultural, industrial and domestic wastewater. The act forbids the dilution or discharge of wastewater without a license, assuming the licensed wastewater treatment facilities are up to the environmental standards. (The Environmental Protection and Pollution Control (amendment) Act 1999.)

The Agriculture (Fertiliser and Feed) Act (1994) defines fertiliser as “any substance or compound of substances, which is intended or offered for sale, or sold, for use in the improvement or maintenance of the growth of plants or of the productivity of the soil; but does not include farmyard or stable manure; kraal manure, compost, wood ash, town refuse or night soil, when sold in its original conditions and under its name”. However, “compost” means decomposed vegetable or mixed vegetable and animal matter forming organic manure. In this piece of legislation, human manure is not discussed in any way. Furthermore, the act states that only registered factories are allowed to produce farming requisites. The act also provides detailed instructions for the chemical analysis of fertilisers. (Agriculture (Fertiliser and Feed) Act 1994.)

5.2.5 Promotion on policy level

Since the legislation does not clearly mention ecological sanitation, its use is not either forbidden or promoted, and the overall view on ecosan is left unclear. The various national policies, however, do not seem to encourage the use of ecosan, and tend to concentrate on flush toilets, inorganic fertilisers and exploitation of groundwater for irrigation. The policies set by various ministries are guidelines for the local authorities as well as communities to show which direction the development is intended to be heading. The following describes the most relevant policy documents and showcases their conflicting motives.

At the beginning of the 21st century, the *National Environmental Health Programme* was formulated. Environmental health and food safety is a multi-sectoral problem, involving the Ministry of Health, Ministry of Energy and Water Development, and Ministry of Local Government and Housing. The main challenges for environmental health include a review of the Public Health Act to meet present day issues to strengthen the multi-sectoral approach to environmental health. The strategies to improve environmental public health include strengthening capacity in the enforcement of environmental health policies and legislation as well as promoting the provision of appropriate and suitable water and sanitation facilities in peri-urban and rural areas. In order to achieve this, the Public Health Act and the Food and Drugs Act and National Environmental Health Policies have been reviewed and developed. (National Health Strategy Plan 2005.)

The National Water Policy (1994) enforces the separation of water resources management from water supply and sanitation as well as increasing the use of technologies more appropriate to local conditions. One key aspect of the policy is to increase the government priority and budget spending on the sector, which already heavily supports plain water resources instead of integrated sanitation services. Programmes on the development of national rural and urban water supply and sanitation have been launched in 2008 to improve the conditions in the country. The target for sanitation coverage in rural areas is 35 % by 2010 and 60 % by 2015, whereas in the urban areas the target is 70 % by 2010. (National Water Policy 1994.) In the light of our current knowledge, the targets are far from being reached.

The National Water Policy also raises the point of the abundance of water resources and assures that the growing demands on water for all its usage could be met. However, the water resources rely heavily on surface water, as groundwater usage is hardly monitored or regulated, as it is privately owned. The policy goes on in stating that although Zambia is generally considered to have abundant water resources, it could experience severe water shortages in the near future due the localised growing demand on water for industrial and domestic use. (National Water Policy 1994.) Water saving in irrigation is supported, but there is no mention of the potential use of or even research on wastewater in irrigation.

With somewhat conflicting views on irrigation, *the National Agricultural Policy 2004-2015* aims at the promotion of sustainable and environmentally sound agricultural practices and irrigation development. However, the policy emphasises

mainly the high potential of underground water aquifers, which are largely unexploited. There are over 1 740 380 million cubic meters of underground water resources, as well as plentiful surface waters. (The National Agricultural Policy 2004-2015, 2004.) *The National Irrigation Plan* (2005) proposes “full, efficient and sustainable exploitation” of these said water resources to ensure the agricultural production of various crops. Of Zambia’s entire irrigation potential, estimated at 423 000 ha, only ca. 50 000 ha are currently irrigated. Zambia has suffered severe droughts from time to time despite the abundant water resources. In soil and crops research, the objectives are to promote sustainable technologies for adoption by small-scale farmers, by developing alternative soil nutrient sources and the use of input technologies. Similar issues are valid in irrigation development, where sustainable technologies and techniques are required especially for small-scale farmers. (National Agricultural Policy 2004-2015, 2004.)

According to the *Integrated Land Use Assessment* (Zambia Forestry Department 2005), most small-scale farmers cannot afford to buy inorganic fertiliser to meet their production requirements. This means that farmers can increase productivity only by expanding the cultivation area or using shifting cultivation, which have negative effects on forest areas. Only 11 % of small-scale farmers buy fertiliser, while less than 1 % invest in irrigation facilities. The poor productivity of land has effects on nutritional health but also on the surrounding lands under agricultural pressure. Crop diversification is being considered in order to improve food security to promote alternative grains such as sorghum or millet, which are not as dependent on fertiliser.

The National Policy on Environment lists the main challenges Zambia is facing as deforestation at 250-300 thousand ha per year, land degradation in many places facing deforestation, soil erosion, inadequate sanitation and water pollution, among other things. According to the policy, the population growth rate of 2.9 % per annum contributes to an increasing depletion of resources. Some reasons for the serious state are, according to the policy, insufficient incorporation of international standards within national legislation as well as the limited involvement of local communities in the implementation and enforcement of related legislation. Also lack of cooperation between the authorities and coordination mechanisms for effective integration of legislation are part of the problem due to insufficient resources. The policy also discusses issues within the agricultural and water sector offering

potential solutions, often different from the policies of other sectors. (National Policy on Environment 2005.)

5.2.6 Legislation enforcement in practice

The law, whatever it may state, is only a tool to achieve desired results. However, ultimately it is predicated on enforcement and implementation to see if the law is effective. In general, the authorities see ecological sanitation as an excellent way to tackle the sanitation problem, especially in peri-urban areas. (LWSC 2008; Lusaka City Council 2010.) The law states that the use of untreated human waste as fertiliser is not allowed, but does not mention separated, diluted or composted waste. Similarly, the law has certain requirements for latrines inside a dwelling as well as near boreholes and kitchens. Otherwise, dry toilets are not specifically mentioned. The authorities do not see anything wrong with ecosan *per se* but underline the correct use of such toilets.

Much of the actual wastewater treatment is dependent on commercial utilities, such as the Lusaka Water and Sewage Company (LWSC), which are in charge of emptying the septic tanks and treating the wastewater. However, in many bigger towns the sewage network does not cover the vast peri-urban areas and the existing network is pushing the capacity of the current treatment plants. It is up to the local authorities to provide the people with sanitary facilities.

The MLGH is in charge of sanitation in general: providing regulations and supervising the sanitary conditions of communities. This is done in cooperation with district councils, which in turn cooperate with village boards and chiefs. The MEWD is mainly concerned with the water resources and the MTENR has the environment's best interests at heart. MACO concentrates on irrigation and fertiliser issues, but has little to say about ecosan. NWASCO is mainly the body in charge of cooperation and putting together water and sanitation resources; however, the ecosan aspect is often forgotten as sanitation is not seen directly as an issue of agriculture or environment. ECZ and MoH are interested in environmental sanitation and its effects on environmental health, but the dialogue between the authorities is down to resources and sometimes proves difficult.

Concerning the amendment of the legislation, it appears that the authorities find it difficult to find a consensus. Evidently all the parties involved seem to think that adding ecological sanitation clearly in the legislation would make matters easier, especially in terms of definitions of which facilities count as adequate and improved sanitation. They also find that human waste as fertiliser should be allowed in the legislation, even though some still require further evidence of its safety. However, no one seems to have the answer to *who* is responsible for changing the legislation. The process is widely known, and it is known that cooperation between authorities is required to form a preliminary draft on the changes, the current situation and public opinion. In fact, few changes are to be expected in the sanitation sector – only the Water Act is being scrutinised by Parliament, and no additional mentions of sanitation are to be expected.

There has been effort to increase the effect of sanitation policies, but the same questions keep coming up: resources, definitions, political will and the unfinished process of decentralisation (O'Neill 2009). However, the latest policies involving sanitation and wastewater treatment are limited to only following the European standards: flush toilets and centralised water treatment. Nonetheless, with the current infrastructure this seems difficult to realise. The abundant water resources seem to discourage sanitation and irrigation methods which save water, which is why the interest towards ecosan is weak. Several people seem to be fascinated by the idea, but implementation lies in the hands of NGOs and donor projects.

It has been a target of the Environment and Natural Resources Management and Mainstreaming Programme (2008) to harmonise the legal regime by identifying and prioritising the needed reforms in the environmental sector and developing an action plan to produce the required policies as well as legal and regulatory instruments. It is especially the environmental policy which calls for cross-sectoral laws and regional cooperation to provide a functioning framework to enforce the laws. (National Policy on Environment 2005.)

However, the Zambian laws on sanitation are spread over many pieces of legislation and responsibility for implementation and enforcement is widespread, and this poses a great challenge to the government. This is due to the large number of actors, each pursuing their own interests and recognising various different issues on sanitation, which has resulted in the development of inconsistencies in the legislation. (Environment and Natural Resources Management and Mainstreaming

Programme 2008.) Often the critical inter-sectoral linkages are ignored, which causes conflicts in policymaking and especially in the implementation phase.

A solution for effective enforcement of laws was believed to be the National Decentralisation Policy (NDP), which was launched in 2003 and implemented for 10 years. The purpose of the policy was to channel and control the resources at district level, as well as to increase collaboration and cooperation between the provincial and local authorities. (National Decentralisation Policy 2002.) This, however, requires the restructuring of resources in all areas and at all levels of society. Central and local government should rationalise their responsibilities within an agreed framework, and active community participation should be required. Provincial and district level institutions should be working in harmony with civil society, which should maintain the ownership and responsibility for the policies. However, as of yet the legislation does not take the NDP into account, nor are local communities involved sufficiently enough to ensure effective enforcement and implementation of the legislation.

5.2.7 Future developments

According to the ministries and local authorities, the legislation in Zambia will eventually change to support the practice, once ecosan spreads more widely and becomes more known. However, as long as attitudes remain suspicious towards ecosan, it is unlikely that the authorities will find the motivation to promote these practices. The priorities of the policy-makers differ and it is challenging to find the political will to channel the development into a new direction (Ascher & Healy 1990). It is questionable whether the practices should direct the legislation or whether it is in fact the task of the authorities to guide behaviour in the desired direction. Additionally, it is important to ask why the current laws do not have the desired effect, such as the carelessly enforced ban of pit latrines. It is not only a matter of culture and environment, but also reflects the needs of the society.

While the legislation on sanitation is sufficient, it does not take into account the conditions in which some people live. This has been dealt with by the authorities by allowing some minor breaches of the law, but the cause itself has not been tackled. The people have the knowledge and ideas on how to build safe latrines, and they

also use human waste as fertiliser, often in secret. If the government would openly promote the ecosan method, these quiet practices might eventually become widely accepted – as it is the authorities who ultimately establish the guidelines for society. Instead of promoting full scale exploitation of the “abundant” water resources, effective wastewater treatment and recycling methods should be considered – if not to save water, then at least to ease the pressure on treatment plants. Cooperation and planning with the commercial utilities might just be the way to learn how to make wastewater recycling profitable and thus desirable. Above all, it is necessary for the ministries to find common goals instead of producing conflicting policies. Otherwise the vicious circle will continue without improvement.

5.3 Case Ethiopia

In this section, another African country is examined with the main goal of understanding the development and progress of sanitation in Ethiopia. While the Zambian case concentrated on the legislation and the political structure, this section will describe the development of sanitation in Ethiopia; by which means and for what motives the progress has been achieved, and how the set goals for the WASH sector can be attained.



Figure 10: Ethiopian toilet and crops. Photo: GDTA/Kyykoski A-M 2012.

Ethiopia was chosen as one case as, unlike in Zambia, the political will towards reaching the sanitation targets has been considerable. Being a developing country with poor assets, in order to gain much improvement on its own terms, several donors and NGOs operate together with the government to achieve common goals. While in Zambia determining the common goals was challenging due to lack of decentralisation, in Ethiopia there has been great motivation towards reaching a decentralised system and integrated goals within the national and local governments.

Ethiopia is a landlocked country of 82.9 million people, of which about 84% are rural, with about 76 % agrarian and 8 % pastoralist communities, while the remaining 16% are urbanites. (World Population Prospects, UN Population Division 2010; GSF 2009.) Ethiopia's economy is based on agriculture, accounting for over 40% of GDP. The total area of the country is 1,127,127 km², with Ethiopia being the world's 27th largest country. The topography of Ethiopia ranges from high mountains up to over 4600 m to one of the lowest areas of land in Africa (the Danakil depression, 125m below sea level). The great diversity of terrain has resulted in wide variations of settlement patterns, natural vegetation and in climate, ranging from nearly freezing point up to 50°C. (GSF 2009.)

Ethiopia has its own unique alphabet and calendar. The country is divided into nine ethnically-based administrative states: Afar, Amhara, Benishangul Gumuz, Gambella, Oromia, Southern Nation, Nationalities and Peoples, Somali, and Tigray; and two chartered cities: Addis Ababa, the capital city of Ethiopia and home of the African Union, and Dire Dawa. The regions are further subdivided into several zones, which are subdivided into woredas, or districts. The approximately 900 woredas are in turn subdivided into kebeles, or wards. (GSF 2009.)

The under-5 mortality rate is 104/1000 live births, and life expectancy is 53/56 years (male/female) (WHO 2009). The percentage of deaths due to water, sanitation or hygiene related disease or injury is 17.8 %, meaning that 192 720 deaths could be prevented with increased access to clean water and improved sanitation (Prüss-Üstün *et al.* 2004).

5.3.1 Sanitation in Ethiopia

The government of Ethiopia supports and advocates the use of appropriate sanitation technology, and follows a “do it yourself” -strategy for individual households – allowing the first step towards a faeces-free environment as being open defecation + burying (so called Cat Method). However, the National Protocol for Hygiene and “On-Site” sanitation states that the minimum standard for sanitation is to have access to a sealed (with super structure to ensure privacy), used, cleaned and maintained latrine with an operational hand-washing facility. In terms of latrine types and designs, a commonly available and nationally accepted sanitation facility in rural settings is the traditional pit latrine, constructed from locally available material. The ventilated improved pit (VIP) latrine with concrete slab and PVC ventilation pipe is common and an accepted sanitation facility in the urban settings of Ethiopia. (GSF 2009.)

The National Hygiene and Sanitation Strategy, which is the closest document to a sanitation strategy in Ethiopia, requires that all households have access to a sanitary latrine. The installation of appropriate latrines with urinals and hand washing facilities at schools, health posts, markets and public places is done by various institutions. Where space is limited in peri-urban/urban slum areas, appropriate communal latrines are to be made available under community (or private sector) management. (GSF 2009.)

The improved sanitation coverage in urban areas of Ethiopia is 29 %, with 9 % still practicing open defecation. In rural areas, the figures look even grimmer, with 19 % enjoying improved sanitation and up to 53 % practicing open defecation. The total figures for improved sanitation and open defecation are 21 % and 46 % respectively. (WHO/UNICEF JMP 2012b.) On a positive note, access to sanitation in primary schools, hospitals and health clinics is 70-80 % and access to drinking water reaches the same level – except in primary schools, where drinking water coverage is only 32 % (WHO2012).

Ethiopia is committed to reach its goals, such as 100 % latrine coverage (both improved and unimproved) and 82 % coverage of improved latrines by 2015. However, the progress has not been as fast as desired and the goal is likely to be missed. Still, important work has been done to improve the sanitation conditions in the country. Ethiopia has, however, made progress on its commitment to improve

the WASH planning and coordination process by strengthening national plans and partnerships. (WHO 2012.) The constructed facilities have been mainly VIPs (ventilated improved toilets), and education on hygiene has been conducted at schools and communities practicing open defecation. There are, however, some challenges that Ethiopia is facing.

Traditionally, the accepted form of latrine is a pit latrine, constructed from locally available material (GSF 2009). The improved models are mainly VIPs (Ventilated Improved Pit latrines) (MoH 2011). Ecological sanitation – dry toilets and reusing composted excreta as fertiliser – is also used to a smaller extent, but there is not enough knowledge about it (MoH 2011; WSP 2011). Interestingly, when examining the data from various national (or semi-national) surveys submitted to JMP covering the years 1994-2010, one can see a growing trend in the types of latrines used. In 1994, a flush toilet (shared or private) was owned by 5.0 % of the urban population; 51 % had a traditional latrine (unimproved pit latrine); in rural areas, only 6 % had an unimproved pit latrine. Thus, the figures for non-access to a toilet were in urban and rural areas 43% and 94 % respectively. In urban areas, development was faster: in 1997, only 30.6 % had no access to a toilet and in 2003 only 17.2 %. However, in rural areas, the coverage remained under 10 % from 2000 (90.7 % without access to sanitation) until 2003, when perhaps a more detailed World Health Survey was conducted, and “only” 79.3% were without access. The figures have reduced, with more and more people gaining access to sanitation - if not improved toilets, then at least traditional pit latrines. (WHO/UNICEF JMP 2012b.)

5.3.2 Ecosan emerging

Finally, in 2005 a Demographic and Household Survey revealed the first composting toilets to compete with flush toilets and pit latrines: urban and rural areas had 2.6 % and 3.7 % coverage of composting toilets, respectively. Five years later, in 2010, the figures for urban and rural composting toilets were 3.9 % and 4.5 % respectively, while the entire country had reached sanitation coverage of 83.9 % in urban areas and 47 % in rural areas (unimproved latrines included). The

development has been fast and the direction good. Also, the trend towards composting toilets is growing. (WHO/UNICEF JMP 2012b.)

There is a reason why composting toilets can be seen as useful for Ethiopia (or any other place). Flush toilets require water and a sewage network. These are difficult and expensive to build into existing infrastructure or over long distances. True enough, in a 2010 survey, only 0.6 % of the entire population had a flush toilet piped to a sewer system. Only 2.1 % had a flush/pour flush system to a septic tank or straight to a pit latrine. Water, in Ethiopia's case, is not the number one solution for faeces transportation. Improved pit latrines (VIPs and latrines with a slab) amounted in 2010 to 8.5 % of the entire population (both urban and rural), while unimproved pits were in a clear majority with 46 % (38.3 % urban, 47.7 % rural). The composting toilet's share was overall 4.2 %. (WHO/UNICEF JMP 2012b.)

From these figures it can be seen that even though more people have access to sanitation instead of practicing open defecation, the majority still have no improved toilet or no toilet at all: the combined figures for people *without access to improved sanitation* are 84.2 % according to the 2010 survey. (WHO/UNICEF JMP 2012b.)

Now, there is a reason why improved sanitation ought to be favoured. Unimproved pit latrines cause hygiene issues, especially during the rainy season, and they can be dangerous for the elderly and children when old pits collapse. Pits constructed near to wells and water bodies can contaminate the water source just like open defecation. Therefore, increasing access to improved sanitation is an important goal also in gaining access to safe drinking water and a clean environment.

5.3.3 Common goals and cooperation

Often it seems that there is no political will to tackle sanitation (O'Neill 2009). However, this does not seem to be the case in Ethiopia, where several government-funded programmes have been launched to improve the sanitation situation in the country, some of which are described in the following.

The recommended approach has been integration and decentralisation of utilities and decision-making bodies. Starting from the top level, it is necessary that the ministries maintain knowledge on what is being done by other ministries. In

Ethiopia, the three concerned ministries – the former Ministry of Water Resources, the Ministry of Health and the Ministry of Education – signed a Memorandum of Understanding (MoU) for joint WASH cooperation in 2006. However, it has been challenging to transfer the WASH MoU to local administrative levels, which have not yet implemented the targets as desired. (Government of Ethiopia 2011; WHO 2012.) There is a WASH inventory being created in order to ease national monitoring and information management on health and water resources. Overall, as there is no sanitation strategy, the WASH issues are fully taken into account in various health, water and waste policies and strategies, which are followed by the said ministries. (GSF 2009.)

Also the role of civil society is a crucial one. The active NGOs in the WASH sector in Ethiopia produced an Annual Joint Report on WASH in 2010. The purpose of the report is to incorporate knowledge from the NGOs to the National WASH Report, produced by the National WASH Coordination Office. The Joint Report also enables the harmonisation of the NGOs' operations as well as cooperation with the WASH administration on the national and ultimately local level. (Government of Ethiopia 2011; WHO 2012.) NGOs were also responsible for introducing ecosan: an NGO called Sudea (eco-san) brought dry toilets and reuse of toilet waste to Addis Ababa and rural areas as well. (GSF 2009.)

Harmonisation is important also at the national level. In recent years, there has been improvement on harmonisation by the three largest official development partners – the World Bank, United Kingdom Department for International Development and African Development Bank – which are now using a single financing modality channelled through the Ministry of Finance and Economic Development. Furthermore, most other water sector development partners have adopted the sector-wide approach, replacing separate project missions with biannual Joint Technical Reviews and an annual WASH Multi-stakeholder Forum. (WHO 2012.)

Donors, which are active in national coordination or harmonisation platforms, are the African Development Bank, EU Institutions, IFRC, the Netherlands, United Kingdom and WaterAid. In addition, there are 13 other donors which are involved and provide over US\$ 1 million in aid. (WHO 2012.) To have the odd 20 donors included in the harmonisation and/or participating in the WASH Forum ensures that

common goals are targeted and resources efficiently spent (WHO2012; WaterAid 2011b; O'Neill 2009).

Education plays a key role also in Ethiopia. Special targets to obtain clean water and improved sanitation in schools help not only in achieving the targets on coverage, but also information on the need for water, sanitation and hygiene spreads more efficiently when reaching children. Meanwhile, in the health sector, a Health Extension Programme training health workers for communities has been on-going for 10 years, and has enabled disease prevention rather than treatment. Training on family health, control of communicable disease, hygiene and environmental sanitation has been well-accepted and has spread through communities. (WHO 2012.)

5.3.4 Tackling attitudes

Work and effort has been put into improving the sanitation situation in Ethiopia, but the main challenge appears to be a problem with general attitudes. People who implement projects and who actually would need improved sanitation do not see the need. Open defecation has been practiced for centuries and especially in some rural areas it can be considered the norm. The other extreme is the will to have flush toilets, as they are seen as the top of the sanitation ladder (Kvarnström *et al.* 2011) and a symbol of wealth and development.

Still, good work has been done in changing attitudes and promoting sanitation. Decision-makers are giving sanitation more attention and good practices are being recognised. Villages which have stopped practicing open defecation are recognised as Open Defecation Free (ODF) and rewarded. Community Led Total Sanitation (CLTS) is becoming more popular amongst communities and other actors, including the government. In 2012, a National Hygiene and Sanitation Task Force was formed to develop and coordinate work done in the WASH sector by donors and NGOs. (GSF 2012.)

The main challenge faced by Ethiopia is the speed of progress; even though progress is being made, it is still slow and insufficient. Limited decentralisation, limited budget and the favouring of more expensive high-technology solutions is not a successful combination. Lacks in capacity, cost recovery skills and level of

ownership by the government cause further delay in achieving the set goals. As many of the challenges can only be solved by the national government, it is important that other actors concentrate on building capacity and ownership on the community level. Several donor-funded WASH projects include micro-financing schemes and training in operation and maintenance on the local level. (COWASH 2011.) Furthermore, the said CLTS method, as well as actions by the government (such as the Health Extension Programme), enable the communities to act by themselves, for themselves.

5.4 Case New Zealand

After studying the state of ecological sanitation in Zambia and Ethiopia, where sanitation statistics have a considerable amount to improve on, and Finland, where rural areas are searching for options for wastewater treatment, it is now time to examine a country where natural elements demand alternative sanitation approaches, even though statistically everything seems to be order. New Zealand has sanitation coverage of nearly 100 %, much like in Finland, as the majority of the population live in urban areas. Nevertheless, dry sanitation is being considered by local town officials, among others, due to the country's proneness to earthquakes.

New Zealand is an industrial country of approximately 4 million inhabitants – and ten times as many sheep. Out of the total population, 86 % live in cities and the annual rate of urbanisation is 0.9 % (2010-15 est.). (CIA 2010.)

With much of the land either pasture or difficult to access mountain range, the majority of people are living in cities. The cities have a reasonable covering of sewage networks, while in rural areas most people rely on septic tanks for their wastewater collection. (Green Earth Development 2013; WREMO 2012b.)

The country is located in the Pacific Ocean, far away from Australia, the nearest continent. The land was formed as a result of volcanic activity, and the mountain ranges prove that the islands are resting on a plate boundary, the *Ring of Fire*. Due to its geography, the country is prone to natural disasters, such as earthquakes, floods and potentially even tsunamis.

New Zealand has approximately 250 public wastewater treatment plants treating domestic sewage from about 80 % of the population, as well as trade wastes from

industry. About 55 % of the population is connected to 25 high rate treatment plants with full secondary treatment in most of them, which produce digested sludge. The majority of treatment plants are small waste stabilisation ponds, which accumulate sludge to be removed from time to time. There is a potential of 77 000 tonnes of dry solids to be beneficially used: 55 000 tonnes produced annually on a regular basis, and 22 000 tonnes removed from stabilisation ponds. In 2003, there were five significant beneficial use schemes for biosolids, which comprised less than 15 % of the total potential biosolids. Today, the figure is somewhat bigger, with treated sewage sludge discharged onto production forests and agricultural land, while a small quantity is sold through retail outlets. In 2007, the goal of the New Zealand Waste Strategy was to compost or beneficially use more than 95 % of sewage sludge. (NZWWA 2003.) That is to say, New Zealand has considered and eagerly implemented the use of treated sewage sludge.



Figure 11: Emergency dry toilets in Wellington, New Zealand. Photo: WREMO 2013.

5.4.1 Ecosan in extreme conditions

Studies have been conducted on sanitation in extreme conditions, but these usually mean developing countries which cannot deal with a major crisis (e.g. Jenkins 2012). In a developing country, where sanitation and hygiene are poor to begin with, sanitation is not always the first priority, but attention is directed towards health care, drinking water and shelter. In industrialised countries, where basic networks and safety nets are already in place, sanitation is one of the most important aspects to tackle. This is not to say that international aid organisations do not do sanitation work – because they do – but to point out that during, say, an earthquake, cholera epidemics are much more likely – and deadly – in developing countries than in industrialised countries. This section concentrates on New Zealand, which is prone to natural disasters, but has managed them well enough in the past.

During exceptional circumstances, such as earthquakes, when the sewage system is not operational, the New Zealand town population in the damaged areas are provided with alternative latrines. Usually the solution has been a portable chemical toilet, which can be installed in the backyard or even indoors. These toilets are used only under crisis situations.

It has been realised, however, that the chemical toilet is not necessarily the best of options. It needs to be emptied relatively frequently and it requires chemicals in order to remain odourless. Recently, alternative options have been explored. The Wellington Region Emergency Management Office (WREMO) has started a pilot project on composting toilets. The goal is to offer the population a more sustainable sanitation option if a natural disaster were to hit.

The project's goal was to determine whether compost toilets are a viable alternative to chemical toilets, port-a-loos and long drops. During the project, people's perceptions were recorded based on their experience on the use, routines and overall outcome of a compost toilet. (WREMO 2012b.)

The toilet used in the project was a urine separating toilet, which could be used indoors. The toilet was composed of two 15 litre buckets; one for urine, the other for faeces. The excreta was collected into a wheelie bin below the toilet, while the diluting of the urine with water for use in the garden was encouraged. The urine bucket was emptied daily to avoid odour. (WREMO 2012a.)

Altogether, 11 households took part in the projects, and all of these households also completed the month-long trial. Toilets and bin were kept clean and hygienic during the project: there were no complaints about odour, manageability or any other issue to public health. The wheelie bins under the toilet were emptied every 3-4 weeks by the city to be composted at a central facility. (WREMO 2012a.)

The pilot has received good feedback from the users, and some of them would be happy to continue with the composting toilet pilot. During the trial period, negativity disappeared by the final week and positive attitudes increased. Also the sense of odour disappeared or diminished towards the end of the trial period; this could either mean adjustment or people learned to use the toilet properly. As a general observation, it was noted that most people will be apprehensive when starting to use the composting toilet in an emergency situation; with proper guidance and support they will be happy after the initial shock. It is also necessary in an emergency situation to remember that the flush toilet may not be in use: old habits die hard. (WREMO 2013.)

Considering that the composting toilet was initially meant for enhancing emergency preparedness, the utility itself was sufficient. The entire unit: two buckets, the unassembled frame and seats could fit into the wheelie bin provided. This could help to motivate storing the equipment until there was a need for it. (WREMO 2013.)

WREMO is planning to test the composting toilet even further, as it has been deemed a well-functioning solution in disaster management. (WREMO 2012b.) The next phase of the project started in 2013 (WREMO 2013).

5.4.2 Feasibility made real

Even though people's reactions have been mainly positive towards the composting toilet in New Zealand, it does not seem to merit the status of an item in everyday use. Attitudes prevent this, as the dry toilet is still considered a second class toilet – a proper toilet still has water. Nevertheless the WREMO project yielded some valuable comments from the users.

It is also important to note that, unlike in many other Western countries, New Zealand does not clearly forbid the use of treated human waste as fertiliser. There

are clear rules on how to treat and utilise sludge, and when asked, the experts were under the impression that no legislation as such restricts the use of compost or urine. (Green Earth Development 2013; WREMO 2012b.)

Legislation can be challenging to study, especially in terms of composted faeces and separated urine. However, most countries do have clear procedures for sewage sludge, and New Zealand is no exception. The New Zealand Water & Wastes Association (NZWWA) has developed guidelines for the use of biosolids, together with the steering group including representatives from the Ministries of Environment, Health and Agriculture and forestry. According to the guidelines,

“[B]iosolids are sewage sludges or sewage sludges mixed with other materials that have been treated and/or stabilised to the extent that they are able to be safely and beneficially applied to land. Biosolids have significant fertilising and soil conditioning properties as a result of the nutrients and organic materials they contain.... septic tank sludges may become biosolids depending on the degree of treatment they have received.” (NZWWA 2003.)

The guidelines list suitable treatment methods, which include pasteurisation, irradiation, lime stabilisation, composting, anaerobic and aerobic digestion, thermal and air drying, and long-term storage. For untreated sludge, the suggested method is disposal by way of landfilling. (NZWWA 2003.) It is noteworthy, when considering ecological sanitation, that the composting of faeces and long-term storage of urine would, according to these guidelines, be feasible means of treatment for toilet waste.

Even though the guidelines are not published by ministries and thus are not government policy, the guidelines supersede those parts of the Department of Health's *Public Health Guidelines for the Safe Use of Sewage Effluent and Sewage Sludge on Land* (1992) that apply to sewage use on land. (NZWWA 2003.) It is thus possible that government policies are superseded by further, “less official” guidelines. There are also separate, quite extensive *Guidelines for the utilization of sewage effluent on land* by New Zealand Land Treatment Collective and Forest Research (Robb & Barkle 2000; NZLTC 2000), much of which follow the WHO standards on effluent use.

The guidelines also mention the risks and hazards of sludge reuse, and include risks from pathogen and metal content as well as organic contaminants (NZWWA 2003). These studies refer to many done in Europe as well as the US, as not all contaminants have been tested in New Zealand. However, the risk assessment does not include pharmaceuticals, which are noted as being a potential threat in Europe.

5.4.3 From crisis to contemporary use

As the WREMO project suggests, also New Zealanders are prepared to use compost toilets in case of emergency; in fact, it was found most preferred these as an emergency toilet option over the chemical loo, port-a-loo and a long drop (WREMO 2013). But could ecosan become the next best thing in New Zealand, even outside crisis situations? At least legislation seems to have no issues with it, and based on the WREMO experience, it would not be a problem for the City Council to arrange a collection, just like household waste is collected from premises (WREMO 2012b).

In the WREMO project, the users found the thought of a non-flush toilet initially unnerving, but everyone was satisfied with the toilet eventually. The use of human excreta in a compost and urine in the garden was not easy for everyone at first, but once they familiarised themselves with the system, the idea became natural to them. (WREMO 2013.) Similar experiences have been found in Finland and Sweden, where dry toilet user experiences have been studied (Engström *et al.* 2011; Fittschen & Niemeczynowicz 1997). The first hand prejudice over potential odour and unhygienic conditions are quickly erased by pleasant user experience, and one does need a natural disaster to opt for a dry toilet: a plumbing renovation, flaw at the water treatment plant or (in Finland, at least) freezing of pipes do not bother a dry toilet owner. As in the WREMO project, the idea of composting the waste and returning the nutrients back to the natural cycle appealed to many users, even though environmental concerns were not in mind when acquiring the composting toilet.

The biggest issue also in New Zealand could potentially be cultural taboos. In Maori culture, the use of human waste on crops can be considered dubious, and the New Zealand guidelines do suggest that the *iwi* (the Maori community) were

consulted before the reuse practice was to begin. Also regular consumers may wince at food fertilised by human-originated fertiliser, but according to the guidelines, reliable information and openness are likely to fix this issue. Returning nutrients back to the cycle cannot be left to people's prejudice. (NZWWA 2003.)

Needless to say, the emergence of the dry toilet next to the flushing norm is not easy initially but the earthy smelling loo quickly wins the hearts of toilet goers – or at least it did so in Wellington. For emergency use, the composting toilet seems to be the ideal way, so could it work in developing countries as well? The issue lies often in crowded cities, where there is no room to dispose of the urine and the compost, and there is no city staff to collect the waste. But compared to uncontrollable raw sludge and waste contaminating drinking water, a composting option might just be what emergency areas want. The system has, after all, been successful also in other areas, such as Haiti (Jenkins 2012).

New Zealand has developed a positive orientation towards composting toilets and could take its emergency preparedness to another level. But would the country be ready for modern indoor dry toilets that need emptying less frequently, that look like an ordinary porcelain seat? Will the New Zealanders follow the lead from other Western states or be the leader in a move to more sustainable sanitation? Time will tell.

5.5 Outside the realm of the cases

The case studies each show a limited picture of how ecological sanitation is treated and implemented in the said countries – all of which have different conditions and challenges. To gain a more general overview on ecosan in the world, the following section describes some further examples from across the globe.

5.5.1 Europe

The European Union has set various directives on wastewater treatment and fertiliser use. Here, attention will only be paid to ecological sanitation or anything related.

The most important piece of EU legislation involving wastewater treatment is the Water Framework Directive (2000/60/EC), which sets out the minimum requirements for water quality – the member states can have tighter regulations. The goal of the directive is to maintain a good standard of water bodies by 2015. The Urban Waste Water Directive (91/271/EEC) is only for wastewater treatment plants for over 200 people, and thus does not state anything for rural areas or on-site sanitation. These are the responsibility of the member states, which must follow the EU standards (i.e. Water Framework Directive) when setting guidelines for household wastewater treatment. All member states have set limits for BOD (biological oxygen demand), while it is also common to measure biosolids, phosphorus and nitrogen. The regulations can be found in national legislation, regulations or municipal guidelines. (Kattainen 2012.) It is thus up to member states to include composting toilets and such methods in their guidelines.

As for the use of sewage sludge in agriculture, the EU has set strict directives. The directives do not cover ecological sanitation, as in many other countries, but concentrate on the use of sewage sludge only. There are a few aspects to consider, such as the timing of fertiliser application (not to be used for grazing until a certain period has elapsed, nor during the growing season with the exception of fruit trees), but overall there are no direct conflicts with dry sanitation and urine diversion use in agriculture. The Council Directive 86/278/EEC of June 1986 states that sludge must be treated before being used in agriculture, but a member state may authorise the use of untreated sludge if it is injected or worked into the soil. The Council Regulation (EEC) No 2092/91 of June 1991 on organic production does not mention human-originated fertiliser. (Richert Stintzing 2007.)

It is interesting that several European countries have no regulations or guidelines on dry toilets. In Norway, Germany, Denmark and Ireland, there is no mention of dry toilets in the legislation, although municipalities may have their own guidelines. In Norway, for instance, dry toilets are quite common in mountainous areas, and in Germany they are used, although they are not considered an option if a flush toilet can be installed. (Kattainen 2012.) There are nearly 200 apartment buildings in Germany with large-volume dry toilets, but as the regulatory framework does not recognise dry toilets, there are challenges in disposing of the waste. Several experts in the ecosan field live in Germany, and there are several pilots to promote dry toilets further. (TDM 2010.)

Some countries, however, have more sophisticated views on dry toilets and have responded to the demand by setting adequate standards.

In France, dry toilets have been officially allowed only since September 2009. There are tight regulations on how the toilet and the collection bin must be (water and air tight), and the waste must be composted on site. Dry toilets are used in approximately 3000-6000 households, and most commercial models are imported. There are several associations offering dry toilet counselling and companies rent toilets for events. (Kattainen 2012; TDM 2010.)

There are dry toilets also in Sweden, mostly in holiday homes, but there are no national regulations specifically for on-site sanitation – some municipalities have their own guidelines. There are, however, several pilots on communal collection and the reuse of human excreta and separated urine. (TDM 2010.) In the 1990s, some Swedish municipalities set separate regulations for on-site sanitation requiring that only techniques that recycle nutrients back to the cycle, namely composting and urine separating toilets, were allowed. The environmental code (1999) stipulated that aspects of sustainable development, including nutrient cycling, were to be taken into account when determining the level of treatment required. (Wallin *et al.* 2013; Drangert 1998.)

Despite the lagging legislation, the general attitudes towards urine diversion are positive in many parts of Europe. Even though there is potential for gaining the public approval for urine diversion, the technological solutions still need to be developed to increase usability. (Lienert & Larsen 2010.)

5.5.2 USA

The United States of America is a major player in any field, so it ought to be seen as a trend-setter also in sanitation. However, in terms of ecological sanitation, there is a little the USA can contribute to the global sanitation situation.

The regulations for dry toilets are drawn up by each state, which causes a great deal of differentiation between the states. There is little awareness of dry toilet techniques amongst the authorities in charge. Some states require the NSF/ANSI Standard 41, but other states have their own regulations. For a homeowner, it is difficult to know how to proceed when wanting to install a dry toilet. (TDM 2010.)

As the standards vary in every state, it is difficult to give a thorough description of ecosan in the US. However, it is enough to conclude that the country relies heavily on waterborne sanitation.

5.5.3 Asia

In Asia, there is a long history of recycling nutrients of toilet waste for agricultural production with composting dating as far back as to the Qin Dynasty in 222-206 BC (Vuorinen 2007). As the Chinese economy is growing fast, however, more and more homes are equipped with flush toilets. Outside the public sewage network, toilet waste solutions are improvised on site, often allowing the liquids to flow into ditches or soil. Modern dry toilets are used in tourist areas. Treated sewage sludge is disposed of in waste dumps and landfills, although pit latrine contents are still used in gardens or fields. (Yang *et al.* 2012; Skoy Plancenter Ltd. 2005.)

The main marketable toilet product is still a flush toilet, which would indicate that the people want a water toilet. However, modern dry toilet models have not been marketed actively, which has not allowed people to upgrade to a more high technology dry toilet instead of flush toilet. (Yang *et al.* 2012; Skoy Plancenter Ltd. 2005.) There are experimental pilots, where dry toilets have been installed in apartments for a more ecological approach. However, due to poor planning or construction errors, the results have not been completely odour-free. (Chinadialogue 2012.)

The Chinese regulations do not give binding requirements for private toilets or their maintenance. Several standards fixate on the hygiene and health aspects of private facilities and quality of night soil treatment. Officially, excreta from public toilets may not be deposited on farmland, but the method is practiced openly. The need for fertiliser is great, so the use of safe compost could benefit the local economy. (Skoy Plancenter Ltd. 2005.) The reuse of sewage sludge is common also in other Asian countries, such as Cambodia (WSP 2012c) and Vietnam (Pham Duc *et al.* 2012).

There are 1.1 billion people who practice open defecation in the world, and 59 % of them live in India (WHO/UNICEF JMP 2012a). Struggling with this sanitation challenge, India is embracing various projects to improve the situation. The Total

Sanitation Campaign by UNICEF, which is also promoted by the Government of India, includes methods of ecological sanitation. For instance, ecosan-based community urinals have been tried in Tamil Nadu and Maharashtra, involving the reuse of urine in agriculture. (IRC 2008.) In Tamil Nadu, people are also getting paid for using the toilet; both urine and faeces being used as fertiliser. This also encourages people to avoid open defecation. (CNN 2008.)

In India, there is also some indication that Muslim children are less likely to die of diarrhoea and other sanitation-related disease (Geruso & Spears 2014). This could be accounted for by the differences in Muslim and Hindu customs in terms of hygiene and sanitation: there is data showing that 67% of Hindu households practice open defecation, while only 42 % of Muslim households do so. (Geruso & Spears 2014.) Even though the difference is not great, it could explain the significance of cultural practice towards sanitation customs. However, there are successful ecosan trials all over India, indicating that the entire population may be accepting towards nutrient recycling despite their cultural background (Myers 2013; Chariar & Ramesh Sakthivel 2011).

5.5.4 Latin America

The focus of the WASH sector in Latin America has in recent years focused on access to safe drinking water. Urban coverage in Latin America and the Caribbean is now 97 % for access to safe drinking water and 86 % for improved sanitation; in rural areas the indexes have reached only 80 % and 55 %, respectively. The most serious situation is in Bolivia and Nicaragua, where 40 % of the population lack access to improved sanitation. (WSP 2012a.)

In Bolivia, there has been a regulatory framework for water and sanitation since 1997. The new Authority for Oversight and Social Control of Drinking Water and Basic Sanitation (*Autoridad de Fiscalización y Control Social de Agua Potable y Saneamiento Básico – AAPS*) was founded in 2009. Administrative Regulatory Resolution 227/2010 aims at improving the monitoring of faecal sludge removal service providers, and requires an environmental permit for providing the service. However, so far there have not been adequate measures to monitor the operations once a permit has been granted. (WSP 2012a.)

In Nicaragua, the legal framework is concentrated on drinking water, although the Ministry of Environment and Natural Resources has drafted a law on faecal sludge management to ensure the sanitary treatment of household wastewater.

In both countries, it is common to have on-site latrines and toilets with no sewage or even septic tanks, which causes faecal sludge to spill into roads and ditches. Most people acknowledge the health risks caused by this, but are often too poor or otherwise unable to do anything about it. The main problem is the lack of institutional regulations, as there are no penalties for failing to meet sanitation standards. Furthermore, there is no surveillance on companies who collect faecal sludge and the industry itself is still at an early stage, with little competition. The prices are high, so it is easier to let the sludge overflow. (WSP 2012a.)

As there is no adequate legal framework or norms regarding on-site sanitation in Nicaragua, often due to lack of human resources, capacity or political will, it is necessary to communicate the problem to local authorities and communities. The sludge, whether treated or not, is often used in agriculture, but so far there are no standards or control over the practice. There is the 620 General National Water Law in Nicaragua, which states that properly treated wastewater can be used for agricultural irrigation, provided that it does not cause any harm to health or the environment. There are no set restrictions, but rather recommended parameters for the quality of reused water. There is a norm, NTON 05 031-07, which determines the standards for the reuse of industrial effluent from the sugar industry, which is currently successfully implemented. Much of the issues with complying with the set norms are the reluctant attitudes from the government as well as lack of knowledge of the potential risks by authorities, farmers and consumers. However, with further training and dissemination, the practice is developing further into a system that would benefit the environment, the communities and the economy. (WSP 2012b.)

*The cycle by which food becomes shit is functioning.
The cycle by which shit becomes food is broken.*

Whenever we flush our toilets, with the conviction that we are performing a hygienic act, we are breaking cosmic laws, because in reality it is a godless act, a sacrilegious gesture of death.

Friedensreich Hundertwasser

6. Sanitation in the future

In order to learn more of the feasibility of ecosan, some methods of futures research were used to map its current path towards potential futures. To better understand the phenomenon, an expert panel was called to ask for a Delphi survey. The survey allowed the experts to share views on how they see the sustainable sanitation situation and its development. Based on the comments of the two Delphi rounds as well as two seminars where the matter was discussed, *environmental scanning* was used to identify megatrends, weak signals and driving forces that might be linked to ecological sanitation. Linking these observations to the PESTEL framework, a Field Anomaly Relaxation (FAR) method was used to draw up futures paths and eventually potential scenarios.

This chapter presents the Delphi survey and its findings, and the following one builds upon these findings and analyses them in the light of the FAR method.

6.1 Delphi survey on ecosan

6.1.1 Background

A discussion forum for experts was organised by the Global Dry Toilet Association (including the author in the organising committee) at Aalto University premises in Espoo, Finland in April 2013. The goal of the event was to gather together a multidisciplinary group of experts familiar with the concept of ecological sanitation and the reuse of urine. The experts were all Finns, but some also had experience in international tasks, overall representing a wide range of sectors from education and research to political decision-making, business, NGOs, local authorities, media and agriculture – the sectors which were considered important also by the participants themselves, who were allowed to invite more people (the so-called snowball method). Out of some 100 invitees, 44 participated. Since so many

sectors relevant to these questions took part in the event, it was decided to conduct a Delphi survey based on the event. Thus, the seminar was planned as a preparatory meeting for the experts to determine the important questions regarding ecological sanitation in the future.

After the event, the discussion was continued in the form of a Delphi survey. A Delphi survey, a research method often used in futures research, is based on an expert panel on a certain issue, in this case the reuse of urine (and ecological sanitation in general). Some thoughts raised from the forum discussions were shaped as claims that the respondents could comment on. They were asked whether the events were likely to occur and whether they would be beneficial. The respondents were also allowed to comment on their responses.

The forum was the source of the questions for the first round of the Delphi survey, and the final form of the questions was shaped by the same group of three people who were responsible for organising the forum (including the author). The methods and theoretical framework described chapters 2 and 3 were used in the process. With the sector analysis of the PESTEL framework and through the mind mapping method, important factors were identified, including technological development, policies and legislation, environmental issues and health. These issues were covered in the expert interviews as well as the seminar, and important questions were raised from these encounters.

The first survey had 23 claims and 3 background questions, and 44 people responded to it. These answers were analysed and another set of claims were drafted, raising the most controversial topics of the first round as well as taking into account the requests of the respondents; it, too, was put together by the forum organisers. The second round had 11 questions and 3 background questions, and 25 respondents. The Delphi survey was conducted as an online Delphi, meaning that the communication was done online in terms of the survey, and the results were analysed in between the rounds and distributed together with the second round invitation.

Sometimes it is useful to have a third comment round to invoke more arguments and discussion on the matter. However, as the discussion started already at the forum and as opinions did not change in the second round, this was not considered necessary. The Delphi survey was conducted in May-June 2013, which also affected the decision to have only two rounds. A seminar was held afterwards in Helsinki in

October 2013 to discuss the challenges of fertiliser use of urine, and the results of the survey were presented there. The discussion did not end there, as further seminars were held in Tampere in May 2014 as well as a forthcoming event in August 2015.

6.1.2 The Delphi method

The Delphi method is often used in futures research: it does not give any predictions on potential futures but rather how experts might perceive the future. The Delphi method can be described as an interview or survey type of research method, where a panel of experts' opinions and knowledge on some matter or phenomenon is determined. It has been used in many fields, from development and strategy work to benchmarking and determining the state of global problems and issues. (Rubin 2012; Rikkonen & Tapio 2009; Juslén & Halmari 1984; Linstone & Turoff 1975.)

The Delphi method is especially useful when studying a phenomenon which is complex, abstract or widespread geographically or concretely. It is also useful when the matter in question is provocative, sensitive in nature, or difficult to define. Typically, the Delphi method is at its strongest in dealing with social or political questions. (Rubin 2012; Linstone & Turoff 1975.)

The Delphi method has six main principles:

Anonymity. The panellists – the experts – are never aware of who answered what in the various questions. Also the manager – the researcher – has no access to that information. The answers and identities are kept separate. This enables the giving of honest answers that cannot be influenced by strong authorities or the sensitive nature of the matter in question.

Iteration. The survey is held several times, usually 2 or 3 times. Each survey lays the basis for the next one, and more information is gathered based on the given answers, which enables the more in-depth analysis.

Communication. The Delphi method is different from an ordinary survey in the sense that the participants may interact with each other during the research. They can change their mind based on comments given by the other panellists. At its best, the communicative nature of the study is when the survey can be filled in real time

together with other panellists online. In more old-fashioned options, the questions of the next round are based on the comments given by the experts in the previous round.

Arguments. Aside from giving statistically valuable feedback by answering the survey, the panellists may also give comments and feedback on why they answered in the way they did and how they interpreted the question. The reasons for answering in a certain way in the survey can be different and this is one important aspect to be studied.

Defined experts. The experts chosen for the panel must be well-informed about the topic in question and represent all sides of society; they must be interested in learning something new on the matter and to view the topic from various aspects. The experts can also name other people as experts.

Learning. A successful Delphi survey gives much to the panellists as well as the researcher. The way of thinking may be changed, new information might be found and enthusiasm towards one's field of expertise may increase after witnessing a large crowd being interested in the same topic.

There are different types of Delphi, which can be categorised as conventional Delphi, Policy Delphi introduced in 1969, and the later developed Argument Delphi. The conventional Delphi includes the traditional panel surveys on technological future development with like-minded experts which were conducted as early as the 1950s. The Policy Delphi brought in heterogeneous views by seeking a variety of views and resolutions instead of plain consensus on major political issues. Argument Delphi, on the other hand, deepens the discussion even further with a multidisciplinary group of experts including at least decision-makers, scientists and synthesisers. It concentrates on the production of arguments and bringing relevant issues to discussion rather than seeking consensus and easy solutions. (Linstone & Turoff 1975; Rikkonen & Tapio 2009.)

6.1.3 The Delphi process

The process starts with inviting the panellists. In this case, the invitations were to the seminar held in April 2013, and the opportunity was used to offer them the option of participating in the panel. The researcher in charge of the Delphi is

referred to as manager, while the manager – in this case, the author - often works together with a working group – as was the case here.

The survey consists of claims about the future of the topic, which are then considered by the experts. Often, the responses are recorded in both a quantitative and qualitative manner: in this case, a 7-step Likert scale was used together with open comments.

The panellists were invited based on their standing in society and active participation in the paradigm of ecological sanitation. The list of invitees was drawn up by a working group, and after the seminar more names were added to the list of people to whom the survey was sent. The goal was to gather people from various disciplines and fields of society from business to research and from policy making to authorities. The invitees were also welcome to suggest additions to the panel.

The invitation to the seminar held in April 2013 was sent to some 100 people, and 44 people attended. In the seminar, the topic was discussed initially with the idea that it would be further handled in the survey as well as in seminars to come. The group work in the seminar acted as basis for the questions in round 1. (The programme for the seminar can be found as Appendix3 – in Finnish with an English summary.) In the seminar, the most important questions were discussed in working groups, and the discussion continued in the form of the Delphi.

After the seminar, the online survey base and claims were constructed, based on the seminar as well as the knowledge learned during the expert interviews regarding case studies. As no actual Delphi software was available, the SurveyMonkey.com online survey internet site was used. A 7-step Likert scale was developed for the experts to evaluate the development of certain claims; the task was to mark down the likelihood as well as the preferability of the stated outcomes, and to comment on why such a response was given. The scale was measured on a scale [-3, -2, -1, 0, 1, 2, 3], the negative end indicating the lower probability and desirability of the outcomes, while the positive scale meant higher probability and desirability (see the form in Appendix 1). The first round consisted of 23 claims on different topics: i) the use of urine in agriculture, ii) technological development, iii) household sanitation, iv) environmental legislation and v) international aspects. In the second round, there were 9 claims from similar themes based on the answers of the first round. In this way, some interesting claims pointed out by a single expert could be

asked from the entire panel, and more in-depth questions could be formed from those of the first round.

In the first round, the invitation was sent to all the seminar participants (44) as well as those people originally invited to the seminar who could not attend: altogether about 100 invitations were sent. In total 44 experts replied to the first round, which is 100 % of the seminar participants, and some 40 % of the invitees altogether, showing the high motivation of the participants. The first round took place in May 2013. In the second round, there were 25 respondents, making the total 19 respondents less. In addition, there were two respondents who had not replied in the first round but who wanted to participate in the second round. It is common for a Delphi survey to lose participants, so the results can be deemed quite acceptable as the respondents still represented a variety of sectors and backgrounds. The second round took place at the turn of May – June 2013, and as the consensus on the matters in question was reached, it seemed unnecessary to have a third round at this point.

The topics varied from reuse of urine as fertiliser and related issues, such as health, hygiene, etc. However, also wider questions were tackled, such as the attitudes towards ecological sanitation, the business prospects and logistical difficulties. In addition to the Likert-scale, the respondents were encouraged to comment on their responses. Even though many chose not to comment at all, the anonymous comments were included in the second round as well as the final presentation of the survey in another follow-up seminar in October 2013 (The programme can be found as Appendix 4 – in Finnish only).

After the first round, the outcome was sent to the respondents, together with the claims for the second round. The claims were gathered based on the responses and comments of the first round, in order for the participants to familiarise themselves with the opinions of others and specify their views.

During the second round, the topics were even more detailed and varied. Some respondents found this difficult or unclear, while others found the topics relevant and important. The goal was to tackle the multitude of issues involving ecological sanitation, as it cannot be addressed as one single matter. The topics were kept complex and even somewhat vague, as in this way it was possible to stimulate comments and a wide range of views from the participants. It was possible for the respondents to clarify their answers after each claim. Most respondents were happy

with this arrangement, although clearer instructions would have produced unified answers. In this way, the respondents were allowed to interpret the claims based on their own knowledge and opinions – as well as to comment on them freely, which is the point of the Delphi method.

The following sections present the results of the Delphi based on themes: background information, urine as fertiliser, technology and business, legislation, and education. All themes will be covered in their own subsections, including the results from the first as well as the second round. The results are presented as diagrams to visualise better whether the outcome was unified or scattered. Cross referencing was done regarding key questions where opinions were wide-ranging. Most attention, however, is targeted on the qualitative results, i.e. the open comments written by the experts. These were analysed thematically and transformed into futures images (more in Chapter 7).

6.1.4 Background information

In the first round, there were 44 respondents, of which 50 % were male and 50 % female. The majority of the respondents were over 50 years of age (Table 4).

Table 4: Age group, 1st round.

Age group	%
20-35	6.8%
36-50	40.9%
51-63	38.6%
over 64	13.6%

The professional groups according to the respondents were as presented in Figure 12. The majority considered themselves to operate in research or business, the third largest group comprised authorities. Four respondents could not find their occupational group or task in the listing, and chose “other”, specifying their backgrounds as sludge operator, university, funding and exercise.

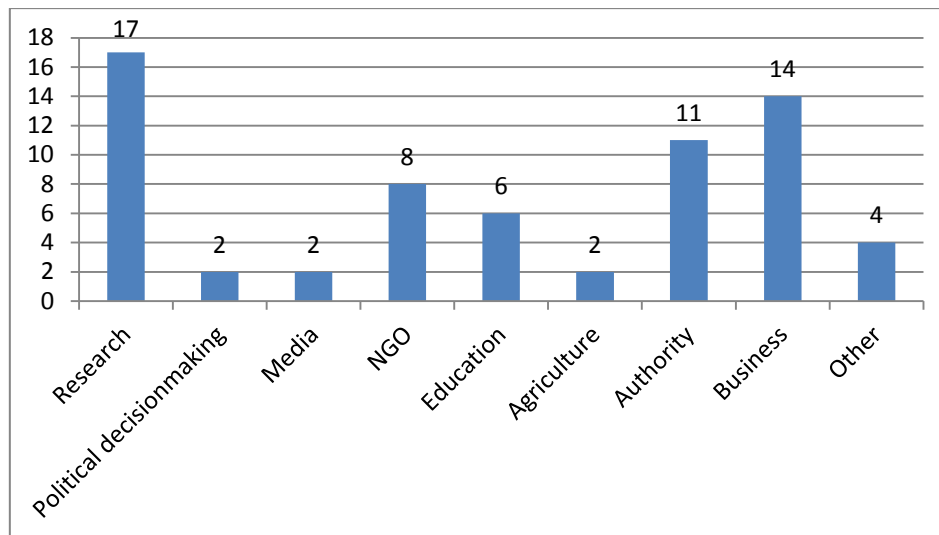


Figure 12: Occupational groups in numbers, 1st round (n=44).

In the second round, the amount of respondents had reduced to 22. Some had notified in advance that they did not have the time or were not available during the second round; others, however, had requested the opportunity to participate in the second round after missing the first round. Nevertheless, the amount of respondents was still sufficient and covered the field reasonably well.

In the second round, the male respondents were slightly more active with a 54.2% response rate, while the female respondents comprised 45.8% (Table 5). The age group divide remained similar, although the largest group was now the group aged 51-63. This is understandable, as much of the knowledge in the field belongs to those with many years of experience.

Table 5: Age group. 2nd round.

Age group	%
20-35	4,2%
36-50	33,3%
51-63	45,8%
over 64	16,7%

The occupational groups were as presented in Figure 13. This time the clear majority represented research (50 %), while education, NGO, authority and business were relatively evenly represented. It is noteworthy that in both rounds all the occupational groups offered to the respondents were represented by more than one respondent. In the second round, the group “other” was not specified. It can be seen

from these charts that all the sectors were represented in both rounds; the groups where responding was not so prominent on the second round included representatives or authorities and the business sector, while some respondents from research and NGO sectors also failed to answer.

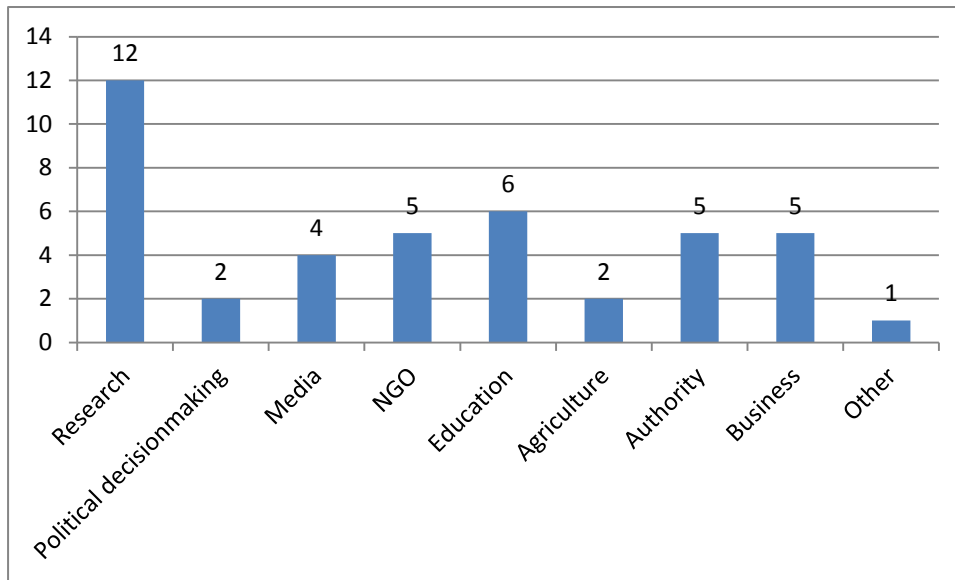


Figure 13: Occupational groups in numbers: 2nd round (n=22).

6.1.5 Urine as fertiliser

As urine use as fertiliser is quite a controversial subject, the main focus of the survey was directed towards the various aspects that are related to it. The experts were asked about their views on urine fertiliser use in 2025.

The first claim of the first round stated straight-forwardly “The fertiliser use of urine will be allowed in landscaping”. Most of the respondents found it desirable, but they could not quite as wholeheartedly state it was very likely in the near future (see Figure 14).

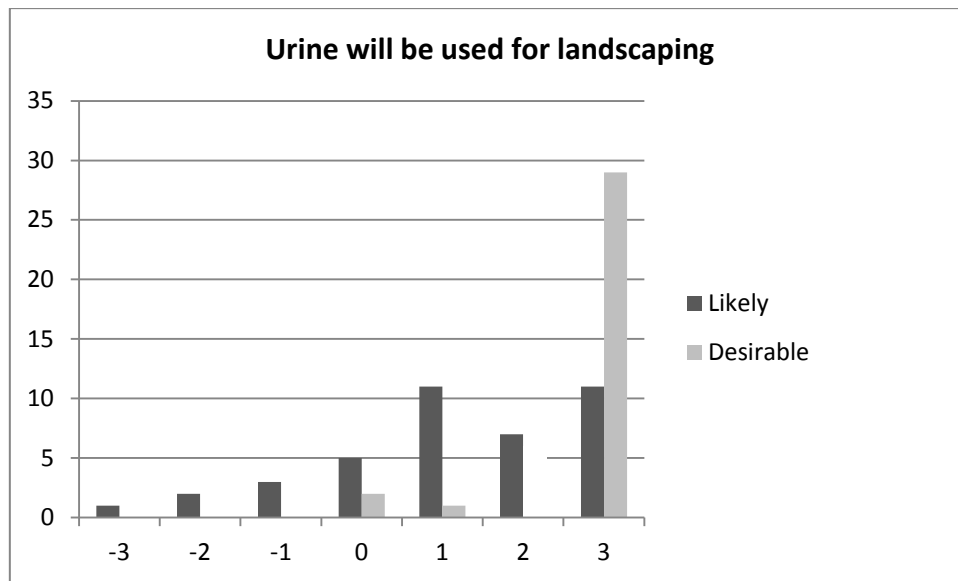


Figure 14: Urine will be used for landscaping: 1st round.

“Food must be produced, if people are to be kept alive. Thus, urine must be taken into use for energy and phosphorus.”

“We either utilise the nutrients in urine and excreta or we cry and utilise them. We no longer have any other option!”

“I think that various closed cycles will increase. In that case, why throw urine to waste?”

Though urine is already allowed for use in gardens, there are still some doubts on the pathological side, so the second claim was “Fertiliser use of urine will be allowed in the production of food crops” (Figure 15). Here, the respondents were not as optimistic, and several argued that it would not be likely nor even desirable.

“Because the great audience finds the risk of pharmaceuticals and hormonal traces in urine a problem, it is easier to use urine for energy production. There is no risk and the general acceptance will be greater.”

“It is necessary to determine the harmful substances in urine and their impact on fertiliser use. Phosphorus resources are diminishing so nutrients in urine should be used in food production.”

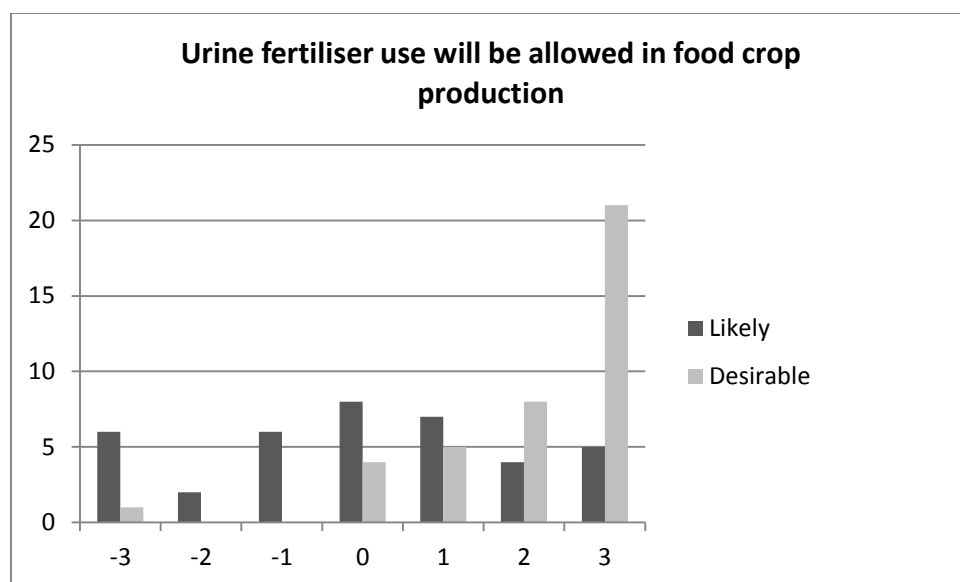


Figure 15: Urine fertiliser use will be allowed in food crop production: 1st round.

The third question increased the valued importance of urine as fertiliser. The claim was “Fertiliser use of urine will be a primary method to guarantee access to food on an international level” (Figure 16).

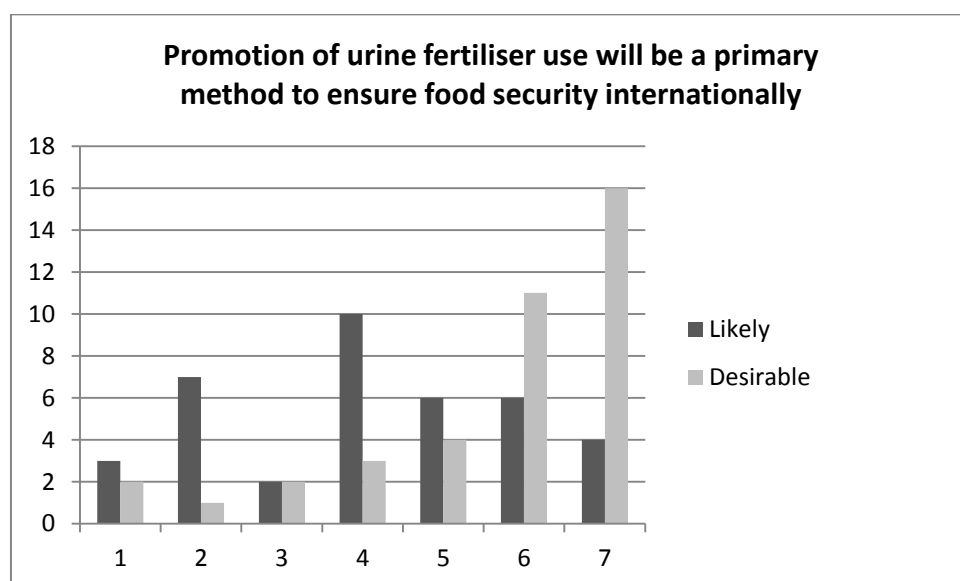


Figure 16: Promotion of urine fertiliser use will be a primary method to ensure food security internationally: 1st round.

Several experts were not enthusiastic in relying on urine as a primary method; however, the majority still found it desirable, although they could not be sure of the likelihood. Some experts commented that they did not know enough about this particular topic, which explains the majority of answers in the middle, the neutral zone.

“Urine and food security are unfortunately not found publicly together. We should find out why it is so.”

“I would not consider the fertiliser use of urine as a primary method but one of many: e.g. compost, sludge, etc. will be strongly part of this until the separate collection of urine is possible on a wide scale. It is also not entirely desirable that this should happen because the long term effects of urine in the soil have not been studied enough.”

“Challenges are the financial interests of industry because urine use does not offer similar business opportunities (at least to the same actors) as the traditional fertiliser industry.”

As the experts already had pointed out that the health aspects must be explored further, the next claim argued that “The health issues of the fertiliser use of urine are known and can be avoided” (Figure 17). Here, the experts were once again hopeful, but not too optimistic.

“Sterile stuff, if urine and shit are bad, then why do we not deal with the enormous amount of chemical pollutants, which we are allowed to use in the name of economic aspects.”

“It depends on the target country. Prevalence: parasites and pathogens. It is relatively clear how long it will take to remove them from urine. Pharmaceuticals and hormones: the problems are not known, but even now we are affected by pharmaceuticals in animal urine and sludge.”

“Fortunately, very good research exists on this, if only it was used and trusted.”

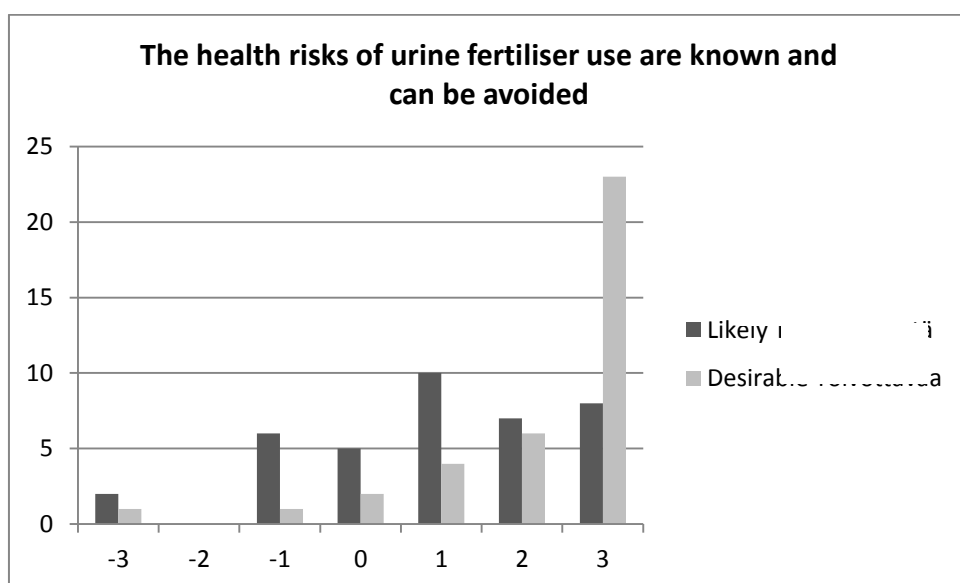


Figure 17: The health risks of urine fertiliser use are known and can be avoided: 1st round.

As the main issue among the experts seemed to be hormones and pharmaceuticals, the following claim continued this line. “The impact of pharmaceuticals and hormones left in urine on aquatic environments, soil and plants is known” (Figure 18).

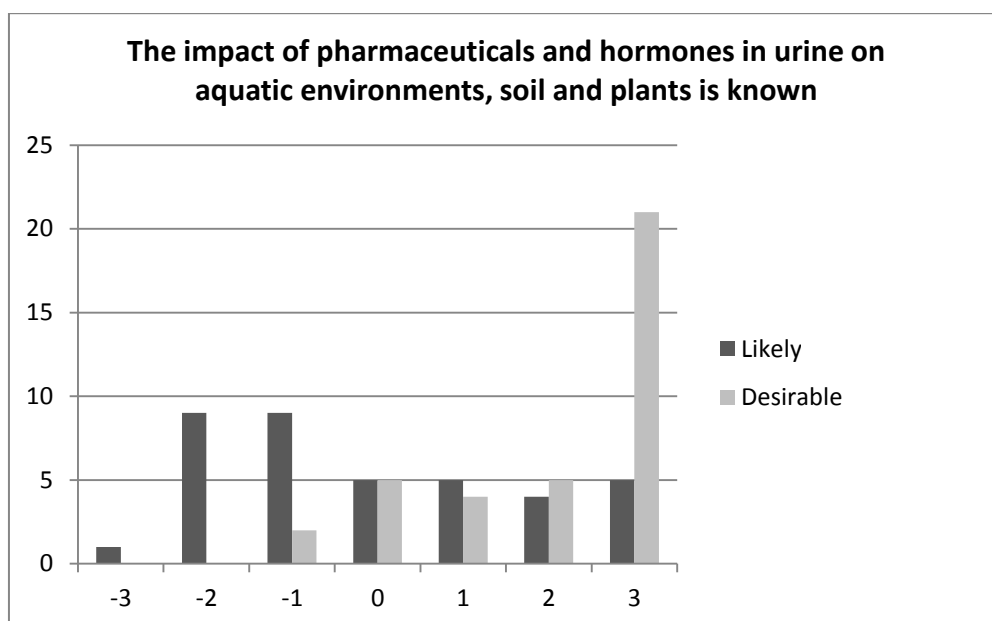


Figure 18: The impact of pharmaceuticals and hormones in urine on aquatic environments, soil and plants is known: 1st round.

Here, again the answers were hopeful, but very sceptical.

“This requires long-term (i.e. decades) research. On the other hand, I do not consider the matter so important, especially from the developing country point of view, where the benefits of urine are bigger than the potential risks, especially in rural areas. The problems are related more to Western treatment plants and megacities, e.g. in India, where antibiotics have already caused the emergence of resistant bacteria and one cause for this has been the amount of antibiotics in waste water”.

“In the soil there are hardly any risks, because the microbes in the soil break down hormones, antibiotics, etc. The modern system, where drugs in urine lead to water bodies is, in fact, a greater risk.”

“Could we not make the wealthy pharmaceutical industry pay for the removal of drug and hormone traces from urine, so we could develop functioning systems for removing harmful substances from urine and dung. Why does society always have to pay??”

“The research conducted so far brings optimism in that soil bacteria treat the traces far more safely compared to the current treatment at plants and eventually to more sensitive aquatic ecosystems.”

The 6th question asked for further means and likelihood of avoiding the impact of the urine fertiliser on aquatic environments, soil and plants. The claims were separate, as it was the wish of the test group to separate knowledge of the effects and methods to avoid them (Figure 19).

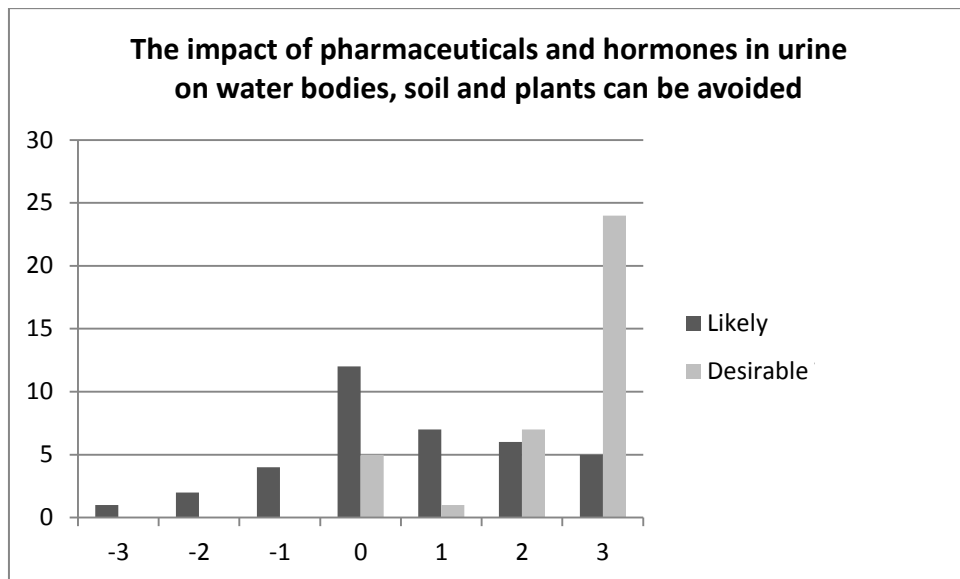


Figure 19: The impact of pharmaceuticals and hormones in urine on water bodies, soil and plants can be avoided: 1st round.

“Dilution and composting are efficient methods, as are UV-treatment, etc. More research is needed on the biodegradability of pharmaceuticals. Some degrade quickly, but e.g. some psychiatric medication and drugs for tropical disease do not.”

“Storing urine for a certain time period and microbes in the soil help a great deal.”

“Man has been to the moon! Even though modern processes and biotechnology surely offer alternatives for this, it is still about the will to solve the matter and put enough effort into research which will support the finding of solutions.”

“I do not think it is right to demand that urine must reach better results in terms of pharmaceuticals and hormones than any modern natural fertiliser used today. The alternative is that pharmaceuticals find their way into aquatic ecosystems; soil is much better alternative.”

As the survey was so far directed mainly towards the fertiliser use of urine, claim No. 7 emphasised also the importance of treating and recycling faeces – due to the fact that degradation of soil is a global problem (Figure 20).

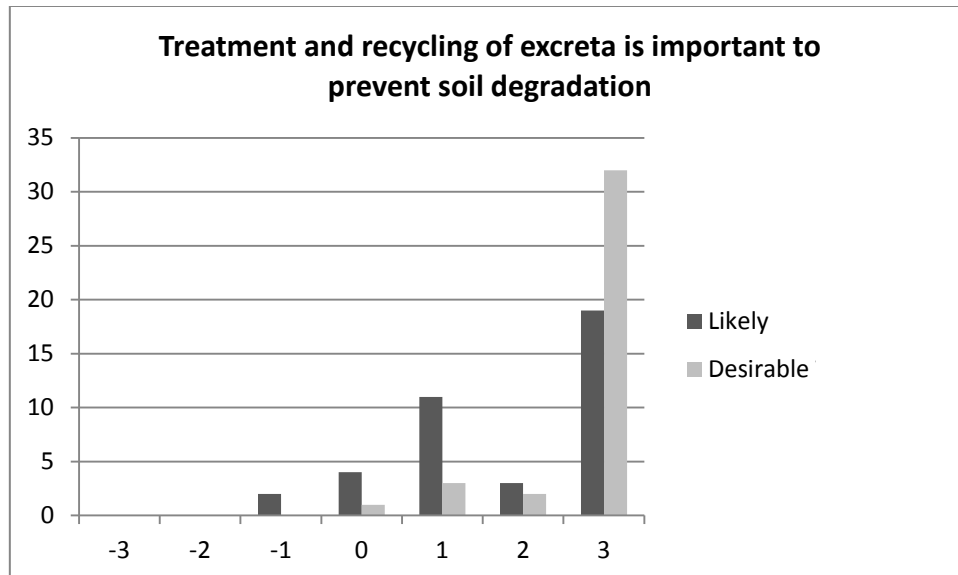


Figure 20: Treatment and recycling of excreta is important to prevent soil degradation: 1st round.

“Recycling toilet waste is much more sensible than just urine. The utilisation would be very easy already if only those insane articles would not prevent it. I consider the centralized collection of septic tank sludge a great threat for development.”

“In modern wastewater treatment nitrogen is lost and phosphorus is bound into a poorly dissoluble form.”

“We must develop small, inexpensive technologies for this, so that ordinary people (i.e. women) can easily use it. Large facilities are only fit for high technology countries.”

“In this way, hazardous waste would become useful. I do believe that closed cycles increase also in this fashion.”

In the *second* round, the time scale was set to 2020, and it was stated – based on some expert comments – that “urine will be used as fertiliser in landscaping and soil improvement, but not in agriculture”. Here, most experts hoped that this would not be the case, but the use would be targeted towards agriculture as well as by other means. Some respondents pointed out – quite correctly – that urine itself is not good for soil improvement but for fertilising, while others pondered whether it was sensible to use urine only for landscaping and gardening. Even though the question was worded according to comments from the previous round, it caused some disagreement as well as confusion. Still, the overall view is clear: it is hoped that urine is used *at least* in some cases, if not in agriculture altogether, but the likelihood of this happening by 2020 was not seen optimistically (Figure 21).

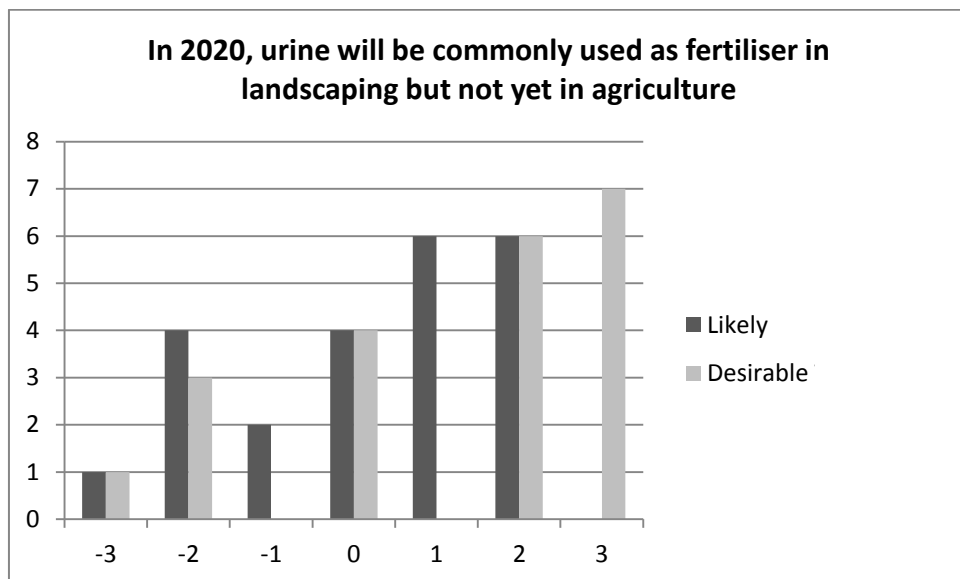


Figure 21: In 2020, urine will be commonly used as fertiliser in landscaping but not yet in agriculture: 2nd round.

“The year 2020 will be here soon. I talked about this with a farmer I know. He is not fond of the idea because of the odour and pharmaceuticals. We should affect the attitudes...”

“Hopefully soon also in agriculture. It is more likely, however, that political and small circle economic interests will slow down the fertiliser use of urine.”

“I find the work is not completely done if urine is only used in soil improvement. The situation is the same with sewage sludge. Good stuff is being wasted in landscaping landfills!”

In the second round, there was also a claim that “Farmers do not care about the fertiliser value of urine because they do not consider nutrient recovery as an important method for gaining fertiliser” (Figure 22). A provocative question, again based on some controversial arguments from the previous round.

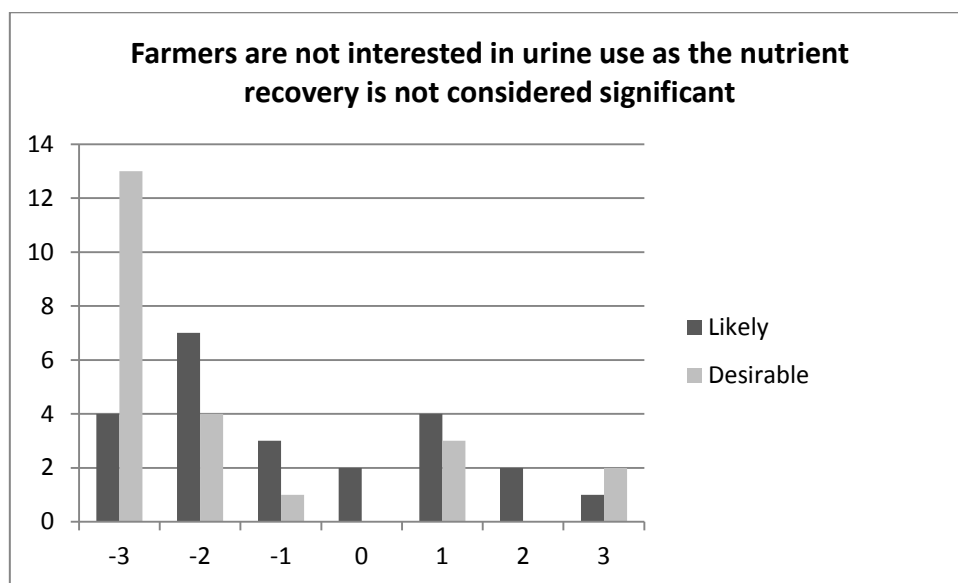


Figure 22: Farmers are not interested in urine use as the nutrient recovery is not considered significant: 2nd round.

According to the responses, the case was not seen as desirable; however, it was considered somewhat likely.

“It is not about them considering the matter insignificant. When the fertiliser prices keep climbing, the opposite will happen. It is more about regulation: how much pharmaceutical traces are allowed in urine used as fertiliser.”

“They won’t be interested as long as synthetic fertilisers have competitive prices. By affecting the fertiliser prices with political guidance, it is possible to change the situation.”

“Farmers will have better education in the future and they can more easily understand that the phosphorus in urine is the purest form of phosphorus available. Surely urine is fast affecting nitrogen fertiliser, which is easy to dose and spread in several rounds.”

“The conclusion of the claim is not correct. Farmers are interested in price and safety. If fertiliser prices increase in the future significantly, their interest will awaken. Odour issues and pressure from neighbours (compare to bad experiences in municipal sludge use).

Based on cross referencing the data, it can be noted that even though there was an overall positive tone towards the fertiliser use of urine, it was generally the authorities and political decision-makers who were less optimistic about the realisation process. Especially the representatives of the agricultural sector found it desirable without exception (Figure 23).

The trend continued during the second round, suggesting that the representatives of the agricultural sector are more ready to adopt the use of urine as fertiliser. It is also interesting to see that NGOs and research institutions seem to have less trust in the willingness of the agricultural sector. (Figure 24.)

However, when discussing the potential dangers of human urine in the fields or the environment, the confidence levels change. Research institutes and political decision-makers consider it likely that the impacts of urine fertiliser will be discovered in the near future: the agricultural representatives and the authorities are less confident (Figure 25).

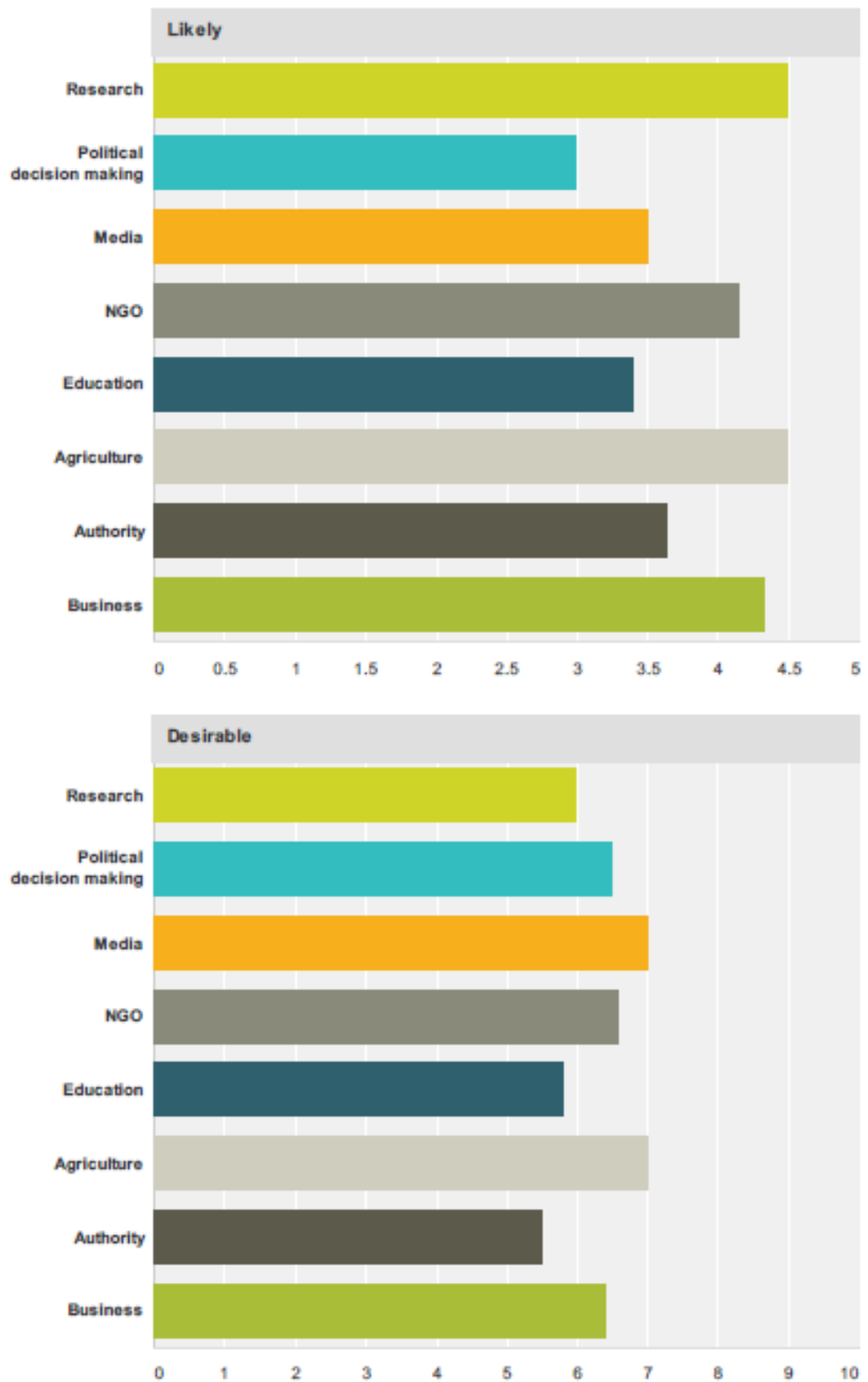


Figure 23: Urine fertiliser use will be allowed in crop production. Cross reference between occupational groups: 1st round.

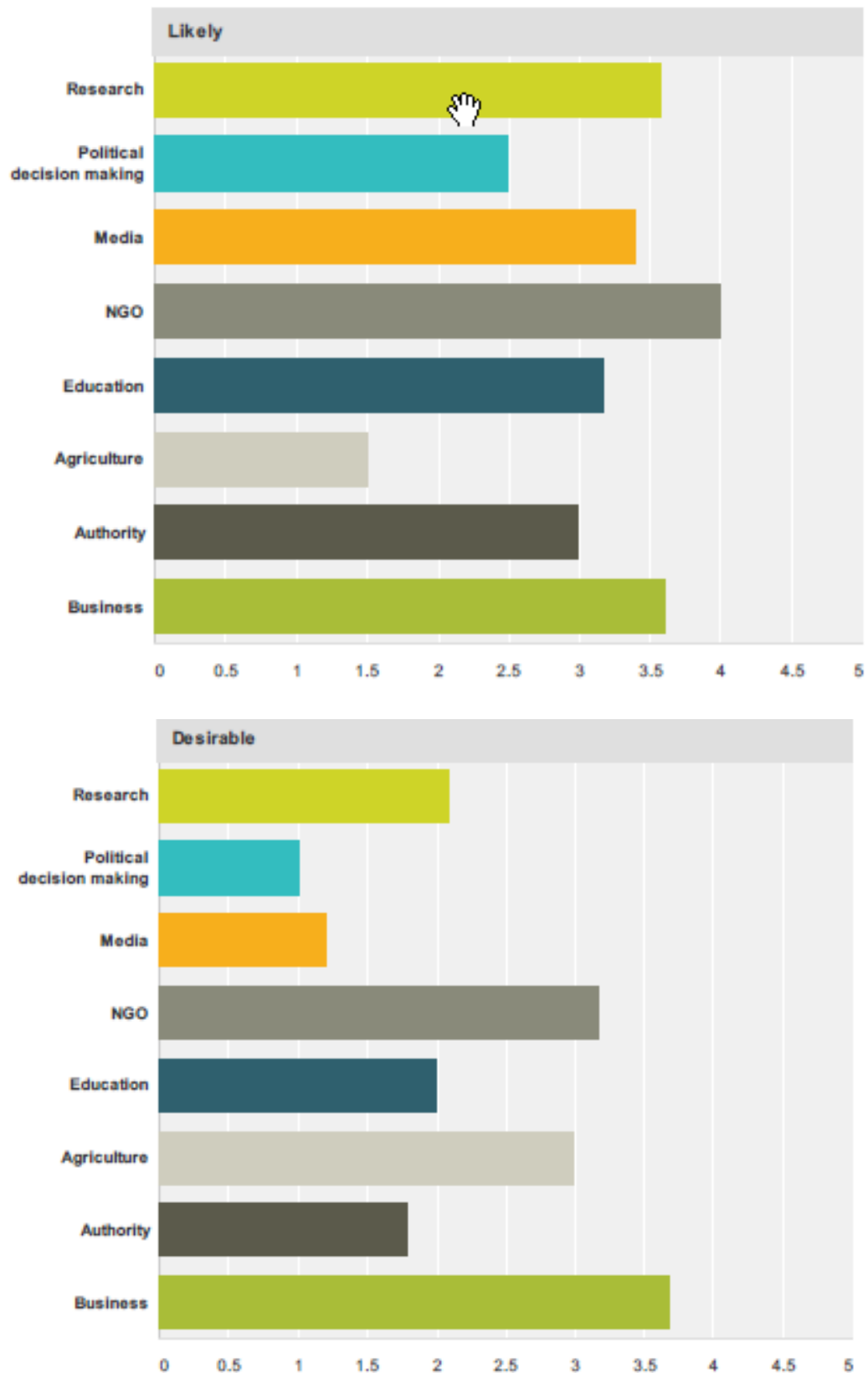


Figure 24: Farmers are not interested in urine use as the nutrient recovery is not considered significant. Cross reference between occupational groups: 2nd round.

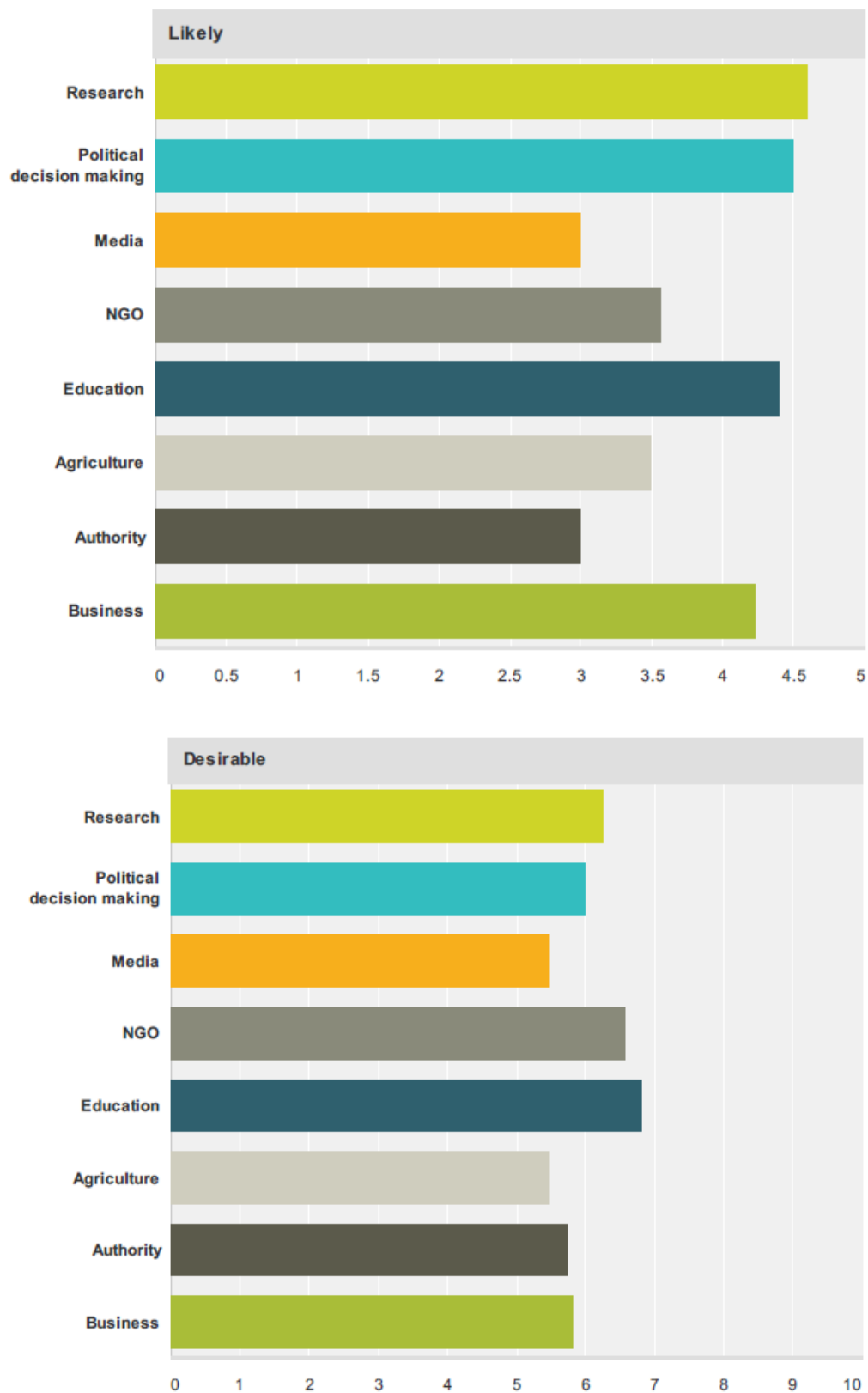


Figure 25: The impact of pharmaceuticals and hormones in urine on aquatic environments, soil and plants is known. Cross reference between occupational groups: 1st round.

6.1.6 Technology and business

In the first round, it was claimed that “Urine diversion technologies will have developed from collecting liquid into collecting nutrients” (Figure 26). Again, some experts informed that they did not know enough about this development, but several still gave valuable insights.

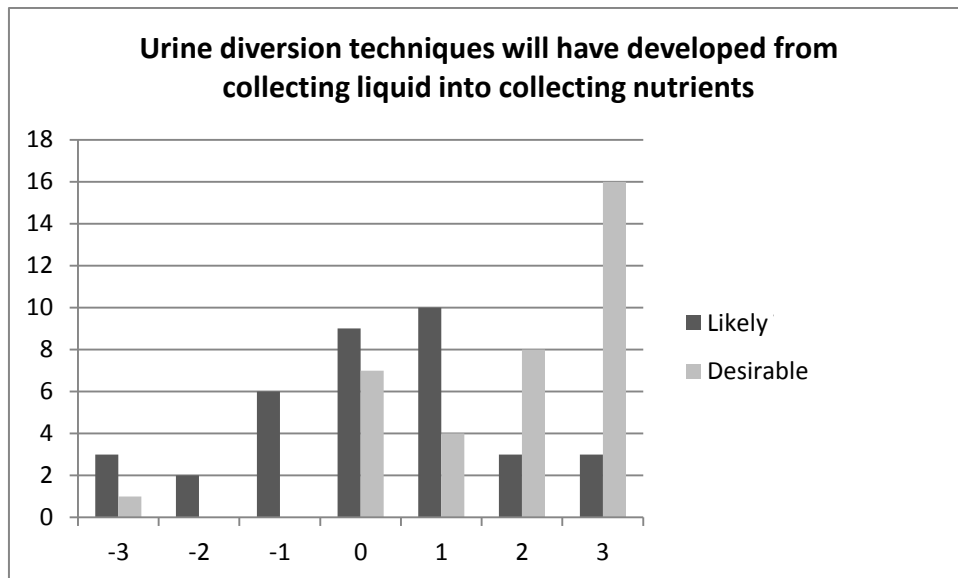


Figure 26: Urine diversion techniques will have developed from collecting liquid into collecting nutrients: 1st round.

As the logistical chain when collecting urine can be difficult to arrange, it has been envisioned that collecting nutrients on a particle level might be a better option. The experts found it desirable, but not likely in the near future.

“Technology can be taken from space technology as the Russians have already done, or water utility technology, where nano filtration would already enable nutrient to be recovered from urine.”

“Separating nutrients from all kinds of waste is the future on the grand scale.”

“Liquid fertiliser is easy to spread with existing equipment. Why would we need to get rid of it?”

The first round also offered the claim that instead of fertiliser use of urine, attention should be directed to the development of wastewater treatment technologies and phosphorus removal from sediment (Figure 27).

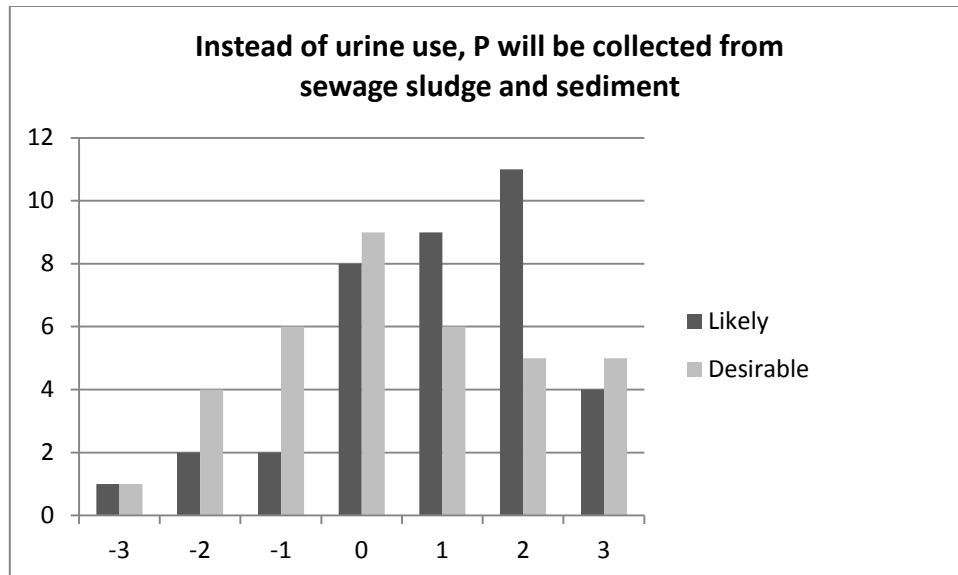


Figure 27: Instead of urine use, P will be collected from sewage sludge and sediment: 1st round.

This was seen as likely and also somewhat hopeful, but again, the experts did not want to limit their views to only one option.

“It is not acceptable to allow the nutrients to escape to water bodies or groundwater with wastewater. Using the old purification techniques is the only option.”

“Probably, at least globally, the amount of water toilets will increase. It would be, of course, more desirable to develop wastewater purification techniques, but I hope that they are not developed at the expense of urine utilisation.”

“Instead of chemical treatment, phosphorus should be recovered in a form more useable for plants.” (Many respondents agreed on this).

“I don’t see these as opposites. This will surely happen as urine utilisation becomes more common, and this could even promote the use of urine fertiliser.”

As something of a “wild card”, the experts were faced with the claim “In addition to urine fertiliser use, it can be used as an energy source” (Figure 28). The claim is based on some technological developments which are directed towards the use of urine as energy (see, e.g. Ieropoulos 2011). Yet, this was not seen as likely or even desirable by many experts. Some, on the other hand, found it extremely desirable. Many experts did not see value in the urine energy content, or did not know about the topic.

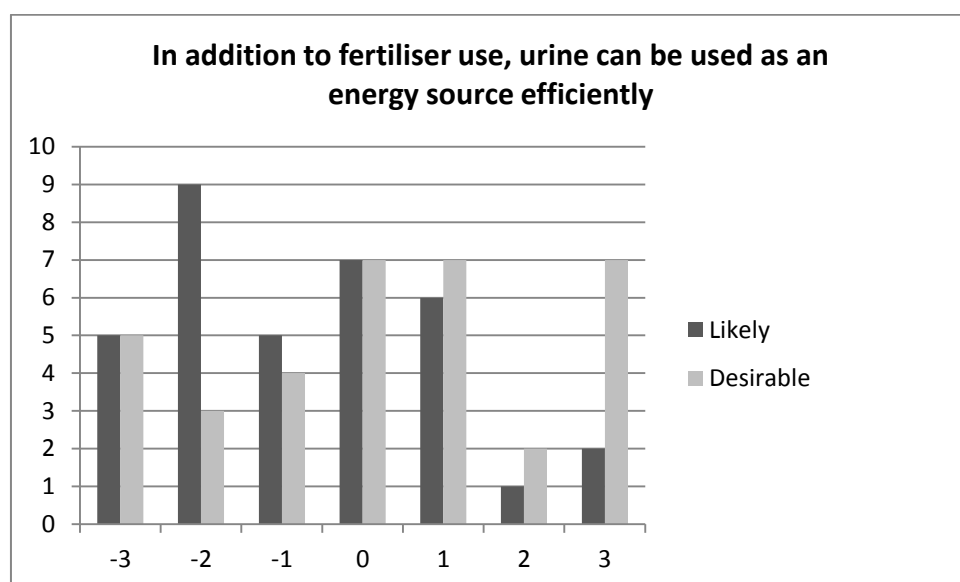


Figure 28: In addition to fertiliser use, urine can be used as energy source efficiently: 1st round.

The usual consensus was that fertiliser use is more important, but there were a few hopeful experts, who, based on the cross reference figure (Figure 29), represented the NGOs or media.

“The methods are still at the research stage. It would be great if the harmful substances could be removed, the energy recovered and finally use the nutrients used as fertiliser.”

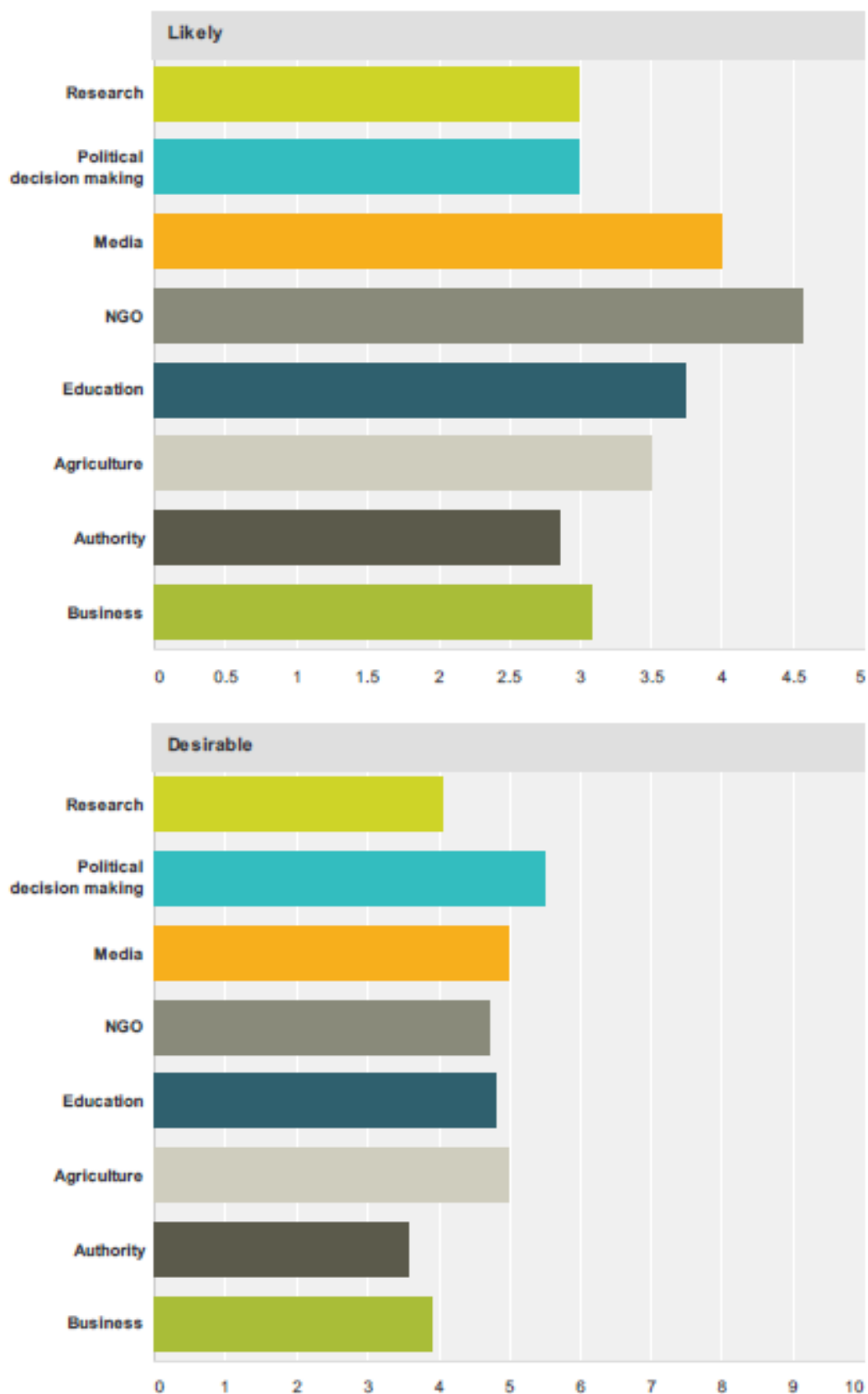


Figure 29: Urine can also be used as an energy source. Cross reference between occupational groups: 1st round.

In the second round, the claim was stated that “Fertiliser use of toilet waste is growing in developing countries, but Finland is not interested” (Figure 30). The claim was formed in this way, since during the first round human excreta as fertiliser seemed to be extremely likely for developing countries, while developed nations had still an option to decline. This progress was not considered desirable, but the likelihood was equally spread.

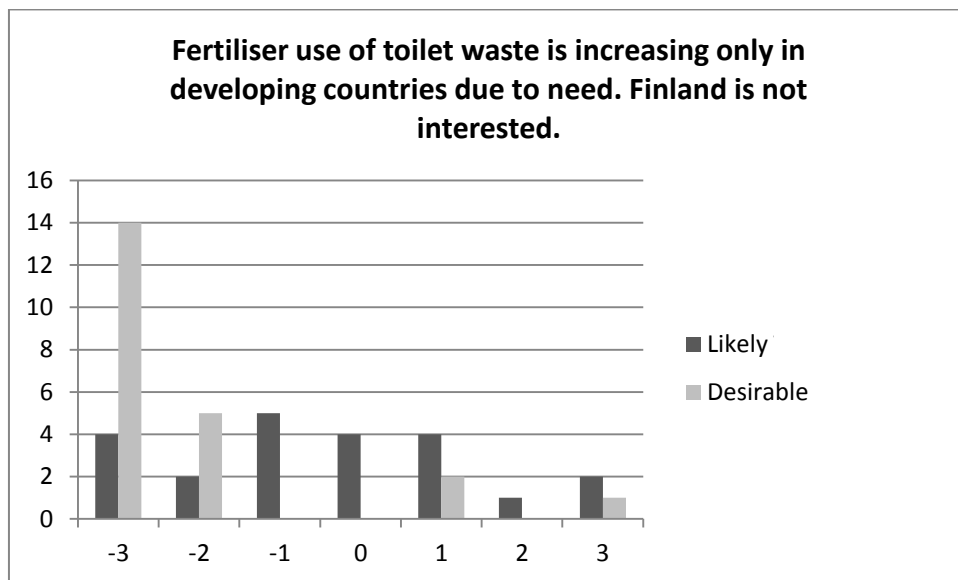


Figure 30: Fertiliser use of toilet waste is increasing only in developing countries due to need. Finland is not interested: 2nd round.

“Unfortunately I don’t believe in fast reactions from authorities and politicians. They do not want to be seen publicly as urine supporters, because it’s easier with the “old fashioned” method. It would be desirable – just to maintain international competitiveness – to take an interest in the topic.”

“The euro is the best consultant and when the price is right, they become interested. Finland will be interested once phosphorus fertiliser price increases.”

“Also in developing countries the water closet is still a goal for many, as long as wealth increases enough.”

The second round also included a question claiming that there will be functioning business models on urine fertiliser use (Figure 31).

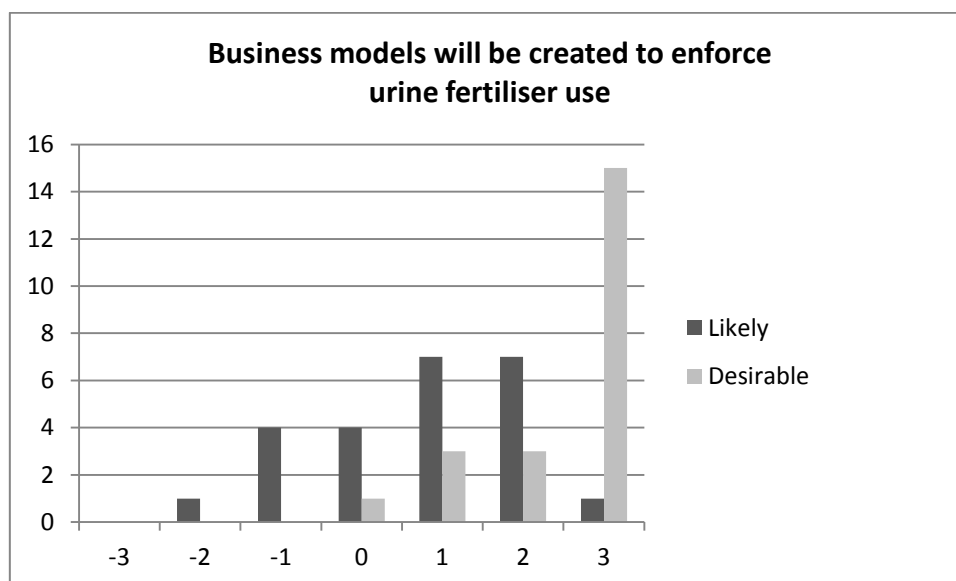


Figure 31: Business models will be created to enforce urine fertiliser use: 2nd round.

This development was considered extremely desirable as well as likely.

“Equipment manufacturer, collection, after treatment...”

“For example, utilising struvite – although it is expensive. Also simply entrepreneurs who spread urine could make a profit out of this”

“Product design, collection and delivery network, sales and use etc. – logistics, wholesale.”

In the 1st round, the claim suggested that “separating dry toilets will become more common in households and public buildings” (Figure 32). This was seen desirable but not very likely.

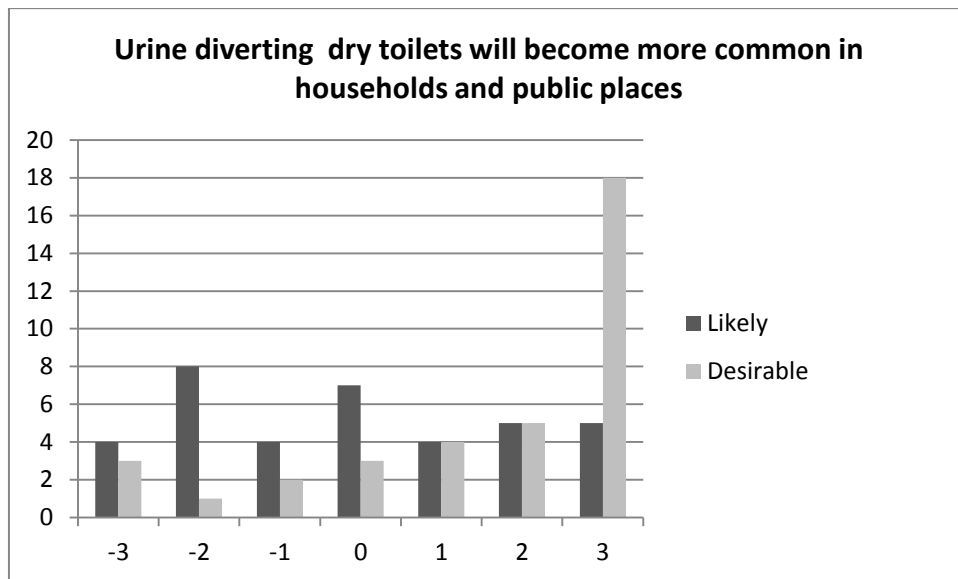


Figure 32: Urine diverting dry toilets will become more common in households and public places: 1st round.

“Waterless urinals for men would be the easiest way to move on, and this is being done widely in Europe. Only we [Finland] do not have these even in public places. For women the separating dry toilet is ok, as long as we can make women believe in it. No flush toilets should be allowed to be taken to developing countries, or anywhere where porcelain is not the norm yet.”

“I believe more in low flush toilets and I find that a desirable development.”

“Much needs to be done in product development before it can happen on a wide scale. Increasing interest in rural areas would be realistic but opposition is strong also in Finland. In other parts of Europe ordinary people find the matter even more distant than the Finns.”

Also the matter of services and business opportunities are being questioned, as many of the comments already show. In the 1st round the claim “services for emptying separating dry toilets will be available for households as well as for larger organisations” (Figure 33) received lots of hope but again its likelihood was in

doubt. The services are there, they say, but again it is an economic matter – who will pay and how much.

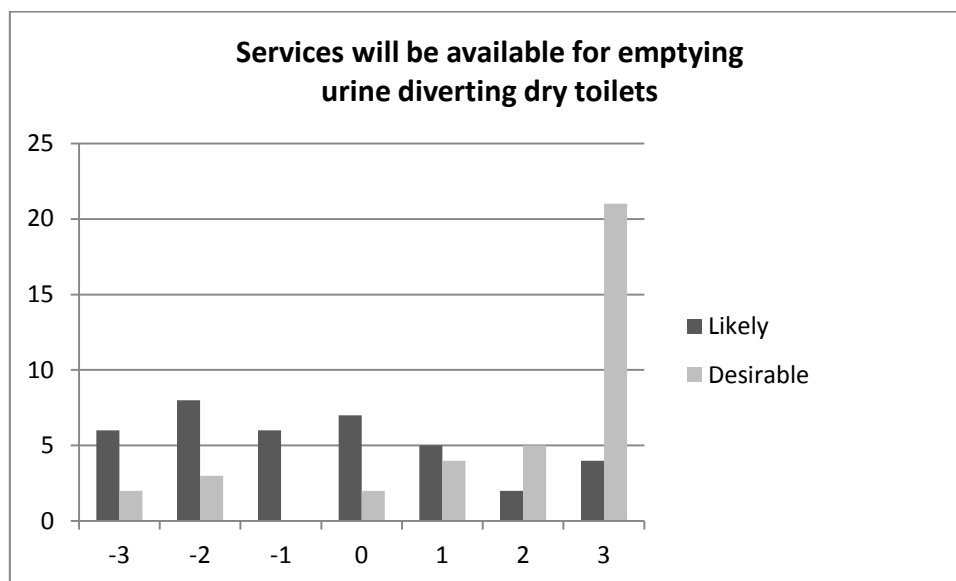


Figure 33: Services will be available for emptying urine diverting dry toilets: 1st round.

“The whole chain must function before dry toilets can become more popular. Also the end use has to be considered and legislation on it must be “sensible”. Some should start offering these services because there is the vicious circle of not having a service provider leading to low demand. It should, however, be productive business in order for it to work; no one will do it for free unless it is included in municipal services (probably in this case the emphasis would be on compulsory joining to a sewage network on account of it being cheaper than separately emptying dry toilets). It could function better in developing countries, although people there cannot afford to pay for services as much. But there the labour costs are not as high.”

“Perhaps one day. One question is, of course, will there be two systems: sewage network and on-site treatment? It should be considered as to how these two can work together in a sensible manner.”

“There are already services available, by different name and they are not successfully marketed.”

From the environmental point of view, it was argued in the first round that “emissions to water bodies from agriculture have been reduced due to more considerate fertiliser use” (Figure 34). This produced positive feedback on both the desirability and likelihood of the outcome. Some reservations were again caused by financial issues and the strong lobbying of agricultural actors.

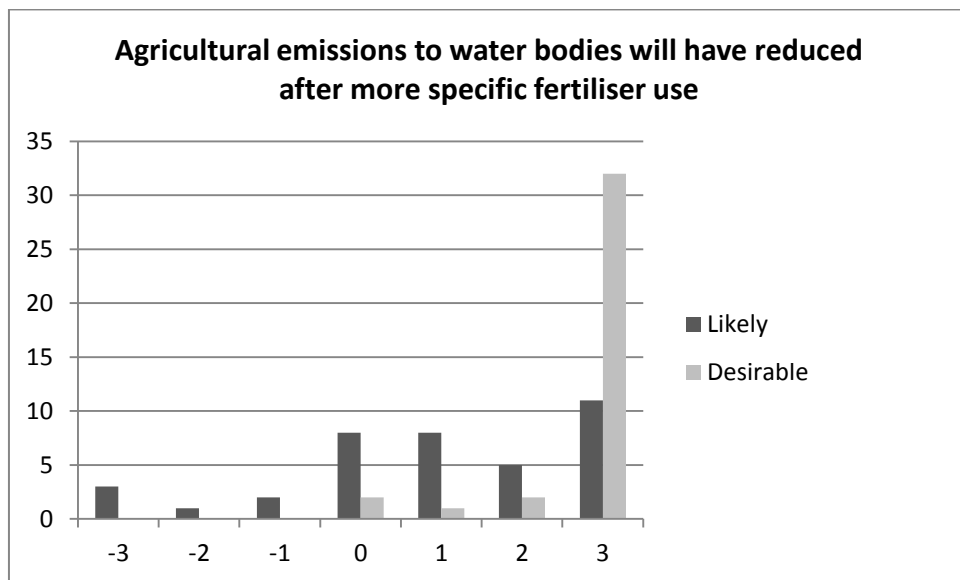


Figure 34: Agricultural emissions to water bodies will have reduced after more specific fertiliser use: 1st round.

“I am somewhat pessimistic about this. Fertiliser use is very efficient already as it is; more important is to improve farming methods and, e.g. use of protective barriers. A new system environmental funding will bring changes which can be seen concretely.”

“Agriculture is a powerful lobby and a strong opponent, therefore it will take time.”

Staying on the topic of business and economy, in the first round it was asked whether organic fertiliser will become an item of export for Finland in terms of sales and consultancy (Figure 35). The experts remained pessimistic, and found it relatively unlikely, yet desirable.

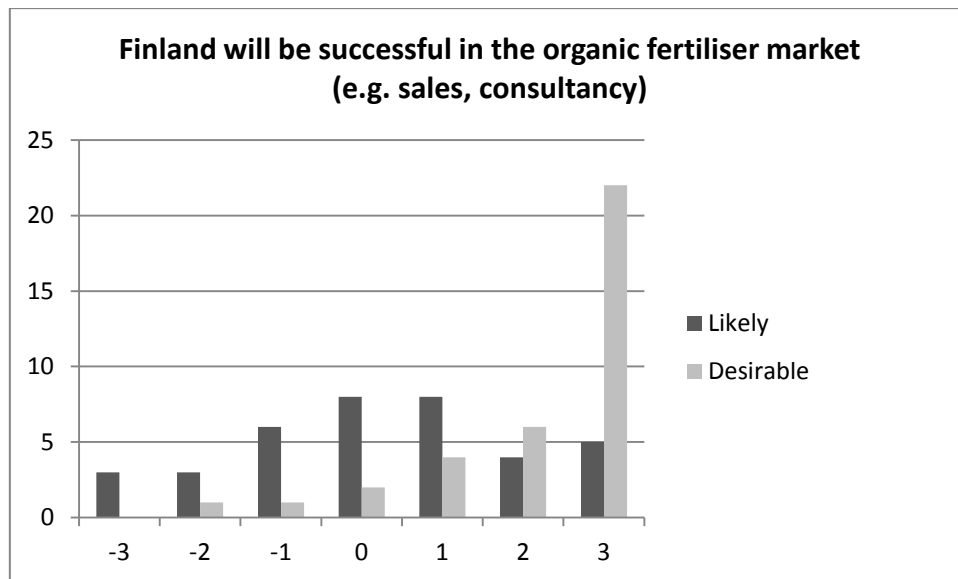


Figure 35: Finland will be successful in organic fertiliser market (e.g. sales, consultancy): 1st round.

“Finland will succeed because it can create top technology, but it should not forget the development of simple facilities and treatment systems. Big is not always beautiful, e.g. in developing countries.”

“This is a field where Finland has good potential: the fertiliser industry and its developed processes, water treatment methods and expertise, a practical approach to “shit”, i.e. if it is possible to be utilized then there are no big cultural obstacles for its use.”

“The ones who will be successful in using organic fertiliser are those who are using it. I have my doubts that Finland would be serious about it.”

The comments from the first round encouraged a claim on how demand might guide the product development of the pharmaceutical industry. The second round featured the claim “The production of biodegradable pharmaceuticals will increase once human waste is used more as fertiliser” (Figure 36) was found extremely desirable and even somewhat likely. However, again, some serious doubts were raised.

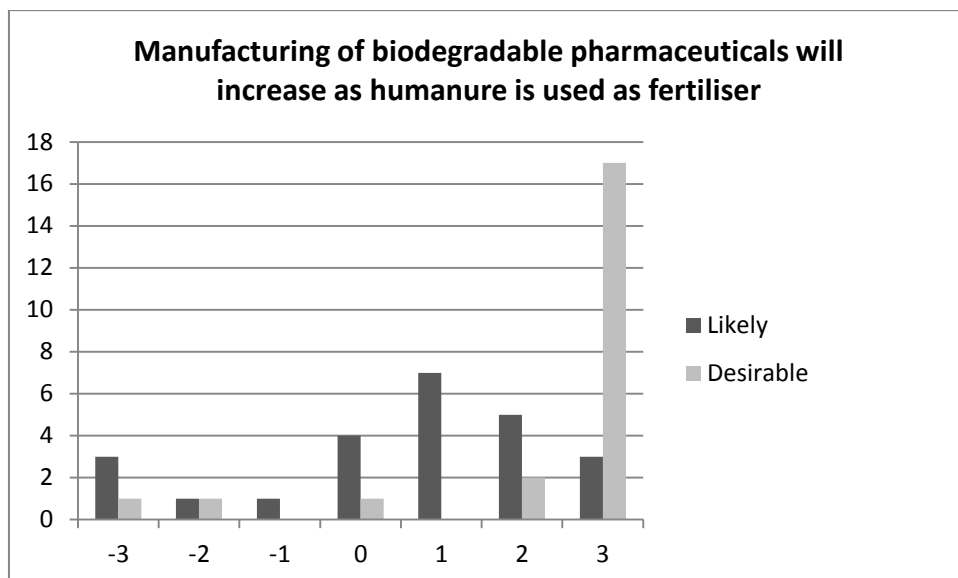


Figure 36: Manufacturing of biodegradable pharmaceuticals will increase as humanure is used as fertiliser. 2nd round.

“The lead criteria for pharmaceutical manufacturing will not likely include biodegradability. First is efficiency, then price, etc. There are already several important pharmaceuticals where one can CHOOSE less environmentally harmful products.”

“We must put pressure on the pharmaceutical industry to develop new environmentally safe products. The bill will not be paid by the user or manufacturer of recycled fertilisers, but the rich pharmaceutical industry should take responsibility for its products.”

“If a drug would dissolve entirely in the body of the user, it would prevent, among other things, the risk of the drug being transferred to a child or foetus and could reduce the risk of medical overdose and development of resistance to drugs. It could also make the dosage of the medicine more certain.”

“It is unlikely that the needs of fertiliser use will affect medical development. Environmental toxicity and harms to e.g. aquatic organisms may play a role, but human wellbeing overcomes all that.”

“The manufacturing will increase, because the breaking down process at wastewater treatment plants is weak. It is not due to fertiliser use.”

Another economy-related claim in the 2nd round suggested that a dry toilet is an option for ready built housing packages (Figure 37). This was seen as more likely, as dry toilets are moving indoors more and more, especially in rural areas as the technology is developing towards more effortless designs and porcelain type seats.

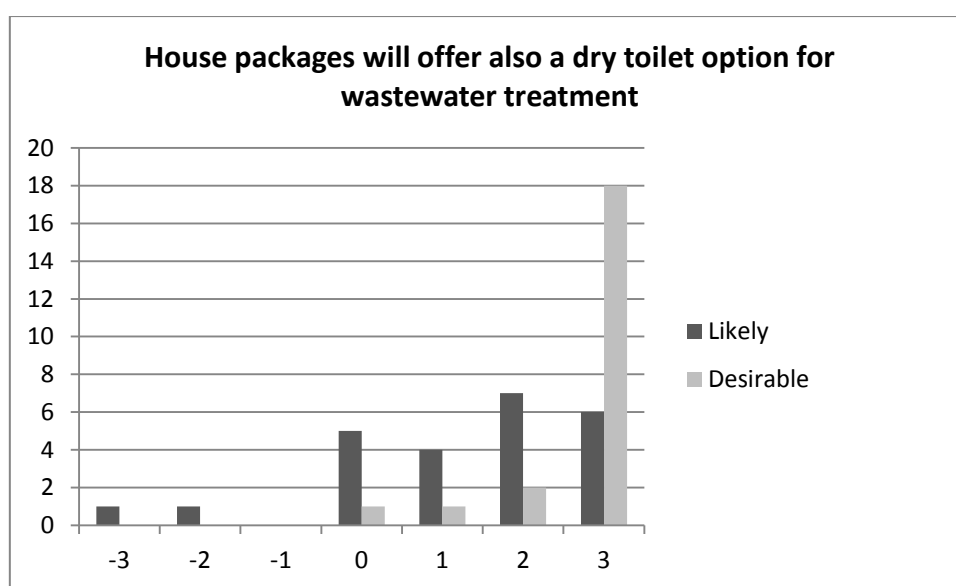


Figure 37: House packages will offer also a dry toilet option for wastewater treatment: 2nd round.

“Many new buildings are built in areas with an existing network, so I have my doubts that housing manufacturers would be interested in this. However, in leisure cottages there is a good chance for dry technology because many municipalities forbid water toilets in shore areas, and when the generation changes in cottage owners, the facilities are updated to more modern options.”

“This could very well be an alternative for house manufacturers.”

“It makes the construction process easier with no toilet waste to be sewaged and treated.”

“It doesn’t seem to interest even cottage manufacturers, it might take longer than the year 2020 before this will become more popular.”

In the first round many commented that the increase of dry toilets might lead on from waterless urinals. In the second round this was asked from all the experts, as the claim suggested there will be waterless urinals in public toilets (Figure 38). Perhaps even surprisingly, many found this to be quite unlikely.

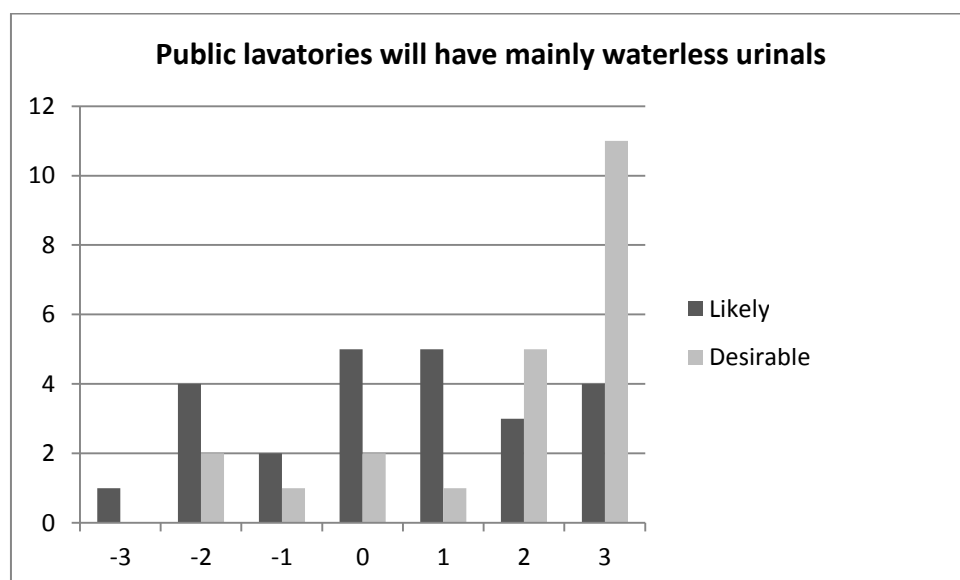


Figure 38: Public lavatories will have mainly waterless urinals: 2nd round.

“If they exist, it doesn’t mean that urine will be collected to be used. That itself is the challenge. It is also challenging because the older generation remembers the time of waterless urinals which smelled. How can we guarantee the maintenance of modern waterless urinals to avoid the odour. E.g. airports are good locations because cleaning works in any case.”

“The saving in water use is then significant. In certain situations (e.g. intervals of events) the same urinal could serve several people in a short time.”

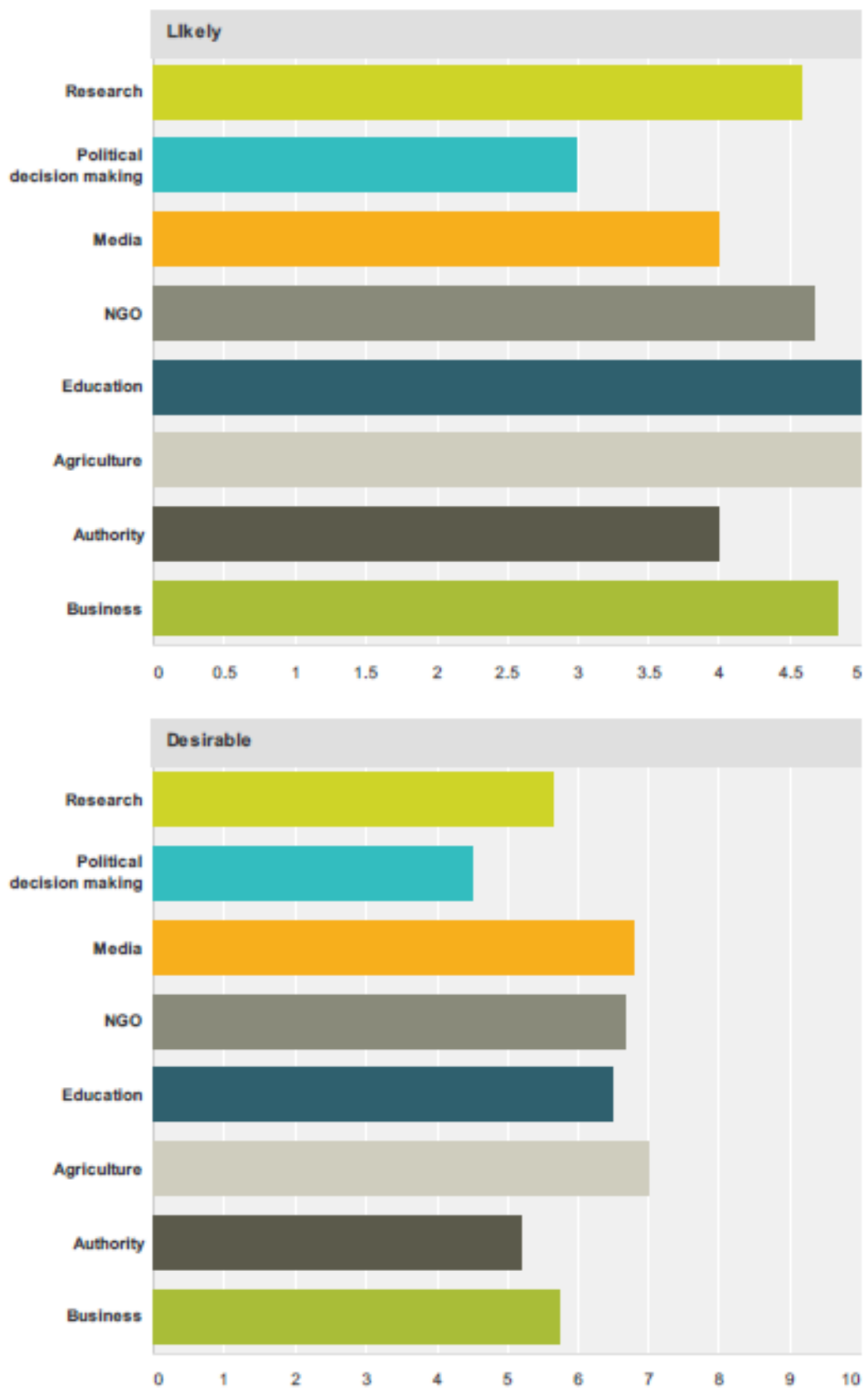


Figure 39: Public lavatories will have mainly waterless urinals. Cross reference between occupational groups: 1st round.

This shows that the odour problems were considered the biggest challenge, as well as the obvious issue of reuse opportunities. The idea of a women's urinal was also raised, and these models have been emerging slowly in several countries. Again, as the cross reference shows (Figure 39), the political decision makers and authorities were the least interested in the waterless urinals in public lavatories. It is noteworthy that the representatives of education, business and agriculture found this progress extremely desirable.

Based on the comments from the first round, the second round also brought up the question of paying to the users the fertiliser value of the urine (Figure 40). Even though this practice has been tried out in some countries (e.g. in India, see CNN 2008), the experts did not find this to be likely at all.

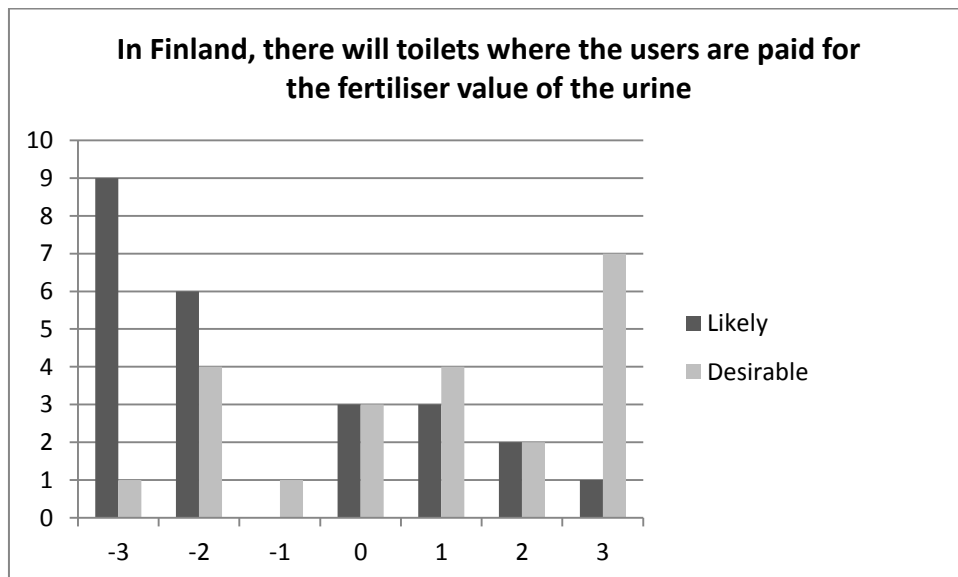


Figure 40: In Finland, there will be toilets where users are paid for the fertiliser value of the urine: 2nd round.

“By the year 2050 there must be enough consciousness of the limits of phosphorus, and the value of phosphorus will increase.”

“Finland is a sparsely populated country; perhaps more in countries where there are a lot of people and no infra.”

“I doubt that the money will turn to this direction. It could be that some costs could be cut. It could be that, e.g. the urine is picked up for free.”

6.1.7 Legislation

Several claims concentrated on legislation in both the first and second round. Also the comments in previous sections showed that legislation is one of the key issues in improving the status of ecological sanitation, dry toilets and fertiliser use of urine and compost.

In the first round, the claim was: “Legislation is being amended to include ecological sanitation and its practices (fertiliser use, dry toilets)” (Figure 41). This was seen as both desirable and likely.

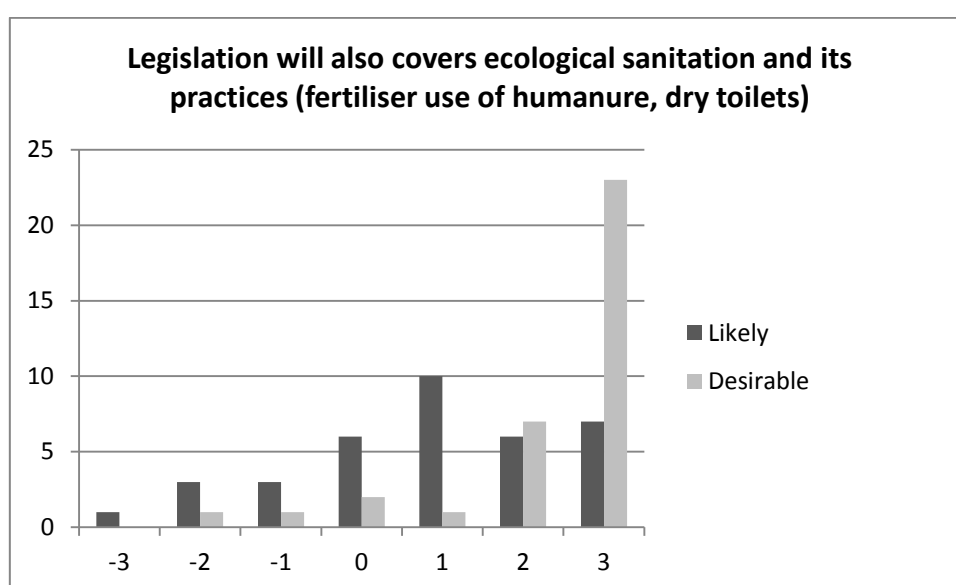


Figure 41: Legislation will also cover ecological sanitation and its practices (fertiliser use of humanure, dry toilets): 1st round.

“It is likely that fertiliser legislation will change and develop on the EU level when fertiliser legislation renewal moves onwards. At this point, a clear set of criteria and sufficient research data must be had for best practices, storage and methods of usage.”

“When making corrections there is always a possibility that things go even more wrong. E.g. the fertiliser act enables the use of human manure but it is too heavy for small-scale operators. The most important factor would be to make it possible for small-scale production, including also, e.g. horse manure producers.”

“There has been some development, e.g. in France. The EU and the like ought to be active, but in a sensible way.”

There was also a question on political strategies during the first round. “Finland will have compiled a strategy for diminishing phosphorus resources together with all ministries by 2020” (Figure 42). This was not seen as very likely, but extremely desirable.

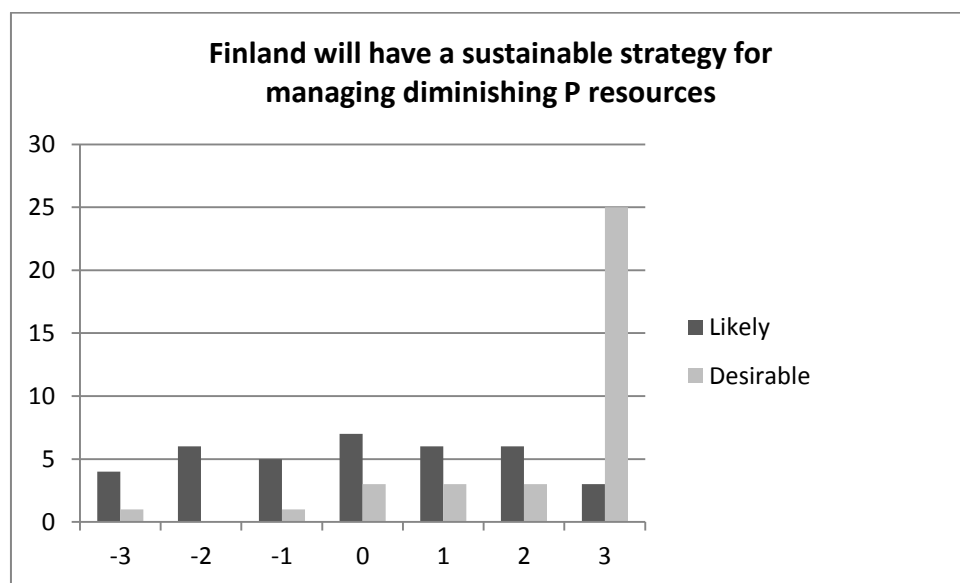


Figure 42: Finland will have a sustainable strategy for managing diminishing P resources by 2020:1st round.

“If MTK [The Central Union of Agricultural Producers and Forest Owners] has woken up then a strategy is surely on its way.”

“There is pressure at the EU level; the commission and some countries have woken up, see e.g. www.phosphorusplatform.org/espc2013.html”

Most of the respondents agreed that a strategy between ministries would be formulated by the year 2020, with some variation between 2018 and 2025. The most pessimistic views pointed towards 2050 and even 2110.

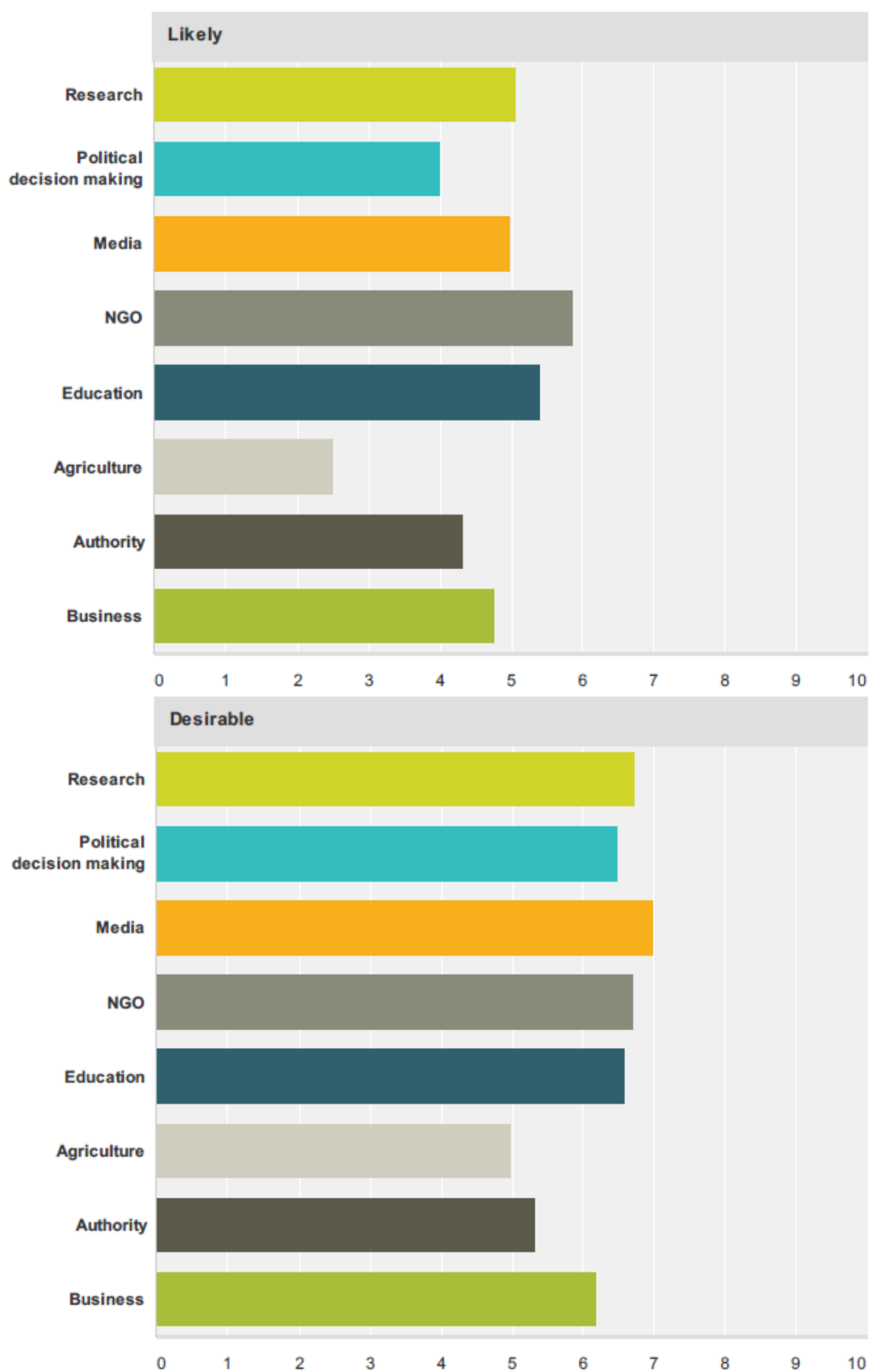


Figure 43: Legislation will also cover ecological sanitation and its practices. Cross reference between occupational groups: 1st round.

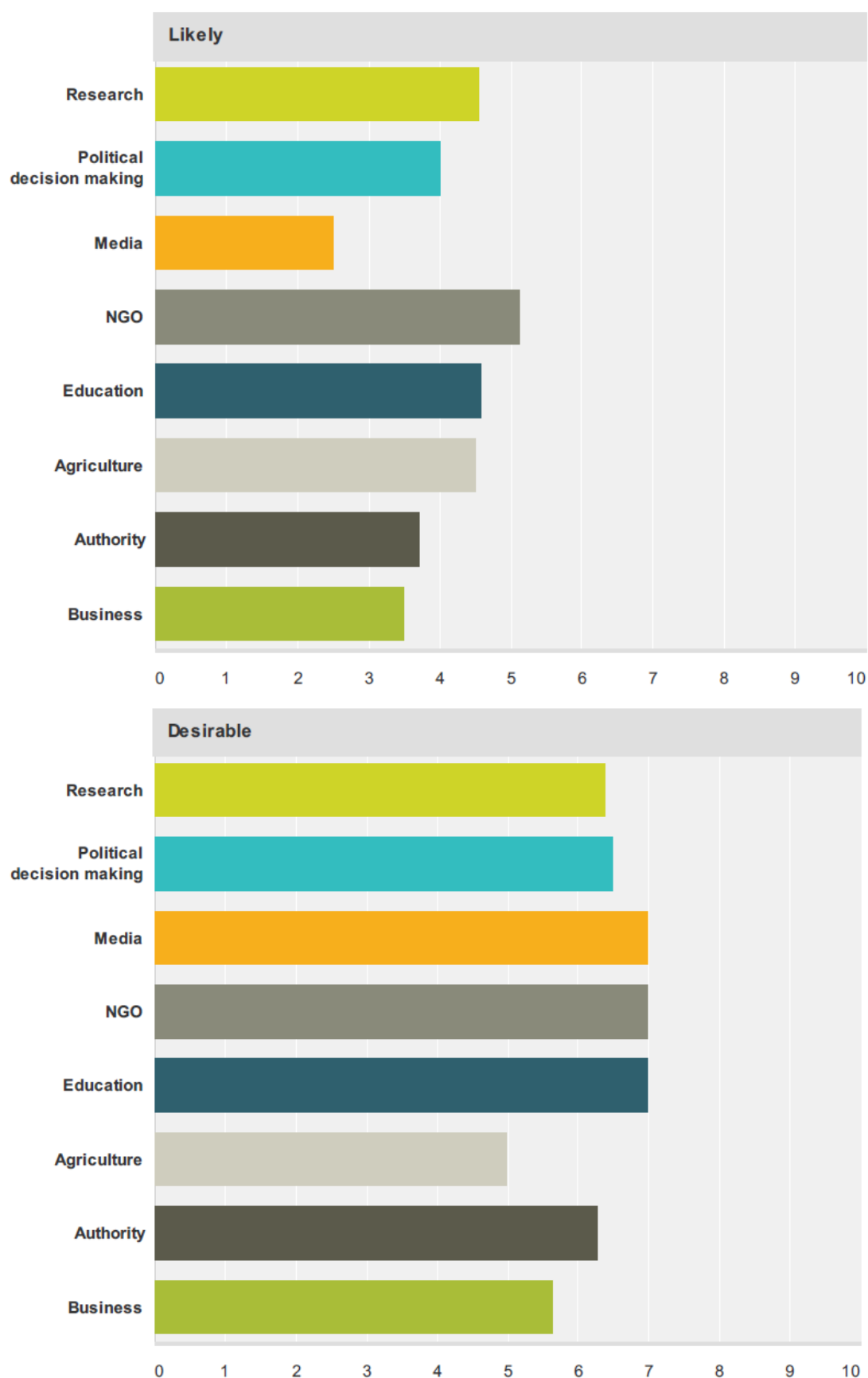


Figure 44: Finland will have a sustainable strategy for managing diminishing P resources.
Cross reference between occupational groups: 1st round.

Here, the most notable finding is the general belief in legislation and policy reforms towards more sustainable sanitation practices and nutrient recycling. In terms of legislation, the political decision-makers and representatives of agriculture are the most sceptical group, while in regard to sustainable phosphorus strategy the doubters are in the media and business sectors. Yet, on both accounts, all occupational groups find the development on the legislation and policy level desirable.

The impact of current legislation was tested in the first round claim that the emissions from rural settlement will be reduced as dry toilets become more common (Figure 45). This was not seen particularly likely as dry toilets are still considered a small part of the whole – and the emission source something other than human toilet waste. There is still faith in the power of legislation.

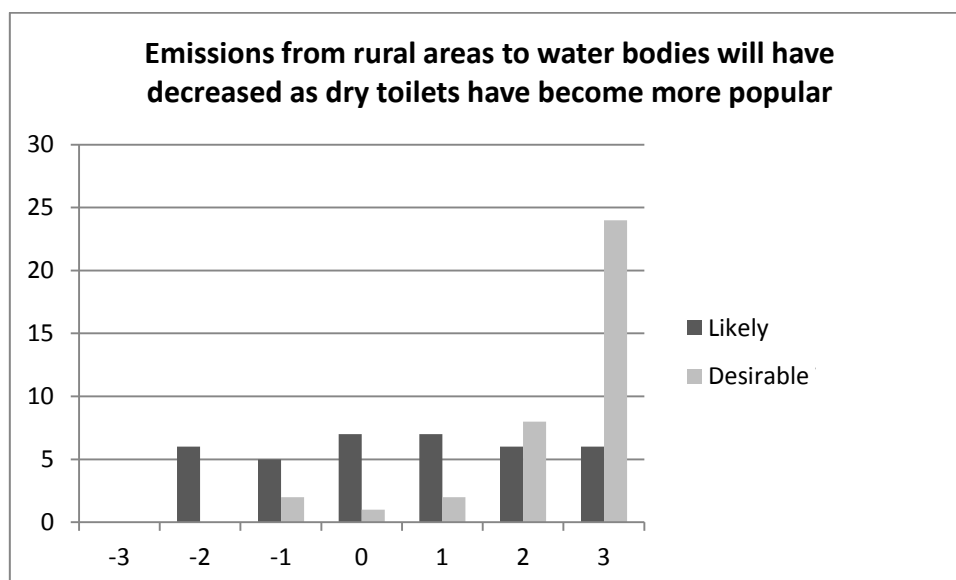


Figure 45: Emissions from rural areas to water bodies will have decreased as dry toilets have become more popular: 1st round.

“Agriculture is still the biggest contributor of emissions, but dry toilets and better treatment of waste water can hopefully reduce emissions, too.”

“Most likely there will be more dry toilets and people will move more to the cities.”

“The emissions will have been reduced due to the act on wastewater treatment in rural areas.”

The first round also discussed the state of urban areas with the claim that a closed cycle of wastewater will be more and more common also in cities (Figure 46). The experts found this somewhat difficult to address, although in general the thought was desirable, but unlikely.

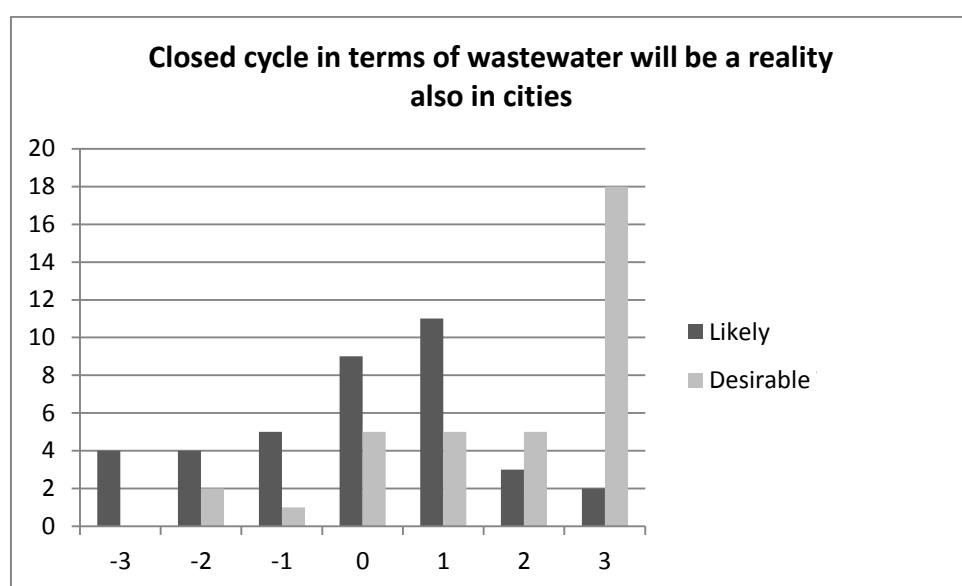


Figure 46: Closed cycle in terms of wastewater will be a reality also in cities: 1st round.

“In terms of wastewater sludge the cycle is functional, but the technologies for recovering nutrients from wastewater have developed slowly, so the costs and other resources do not support this development.”

“Fully closed systems require a great deal of chemicals and energy in order to function, which leads to new problems replacing the old.”

Most of the commentators agreed that a fully closed cycle in wide scale use in urban areas would be too expensive to maintain as operational. There was also doubt that there would be enough motivation to strive for a closed cycle as there is also a relatively well-functioning open cycle available. Most of the experts wanted

to concentrate on improving current technologies, whereas some still remained hopeful that economic closed cycles could find their way also to the cities.

6.1.8 Education

The final topic that both the first and second rounds dealt with was education, as it is an important part in moulding the direction of development where Finland is heading. Knowhow and professionals play a key role in developing new technologies and methods, also in sustainable sanitation.

A claim from the first round declared that “Professionals in sustainable sanitation will be trained in Finland in addition to sustainable water management” (Figure 47). Again, the views of the future were desirable but not very likely. However, some hope remained and the experts did not fully turn this idea down.

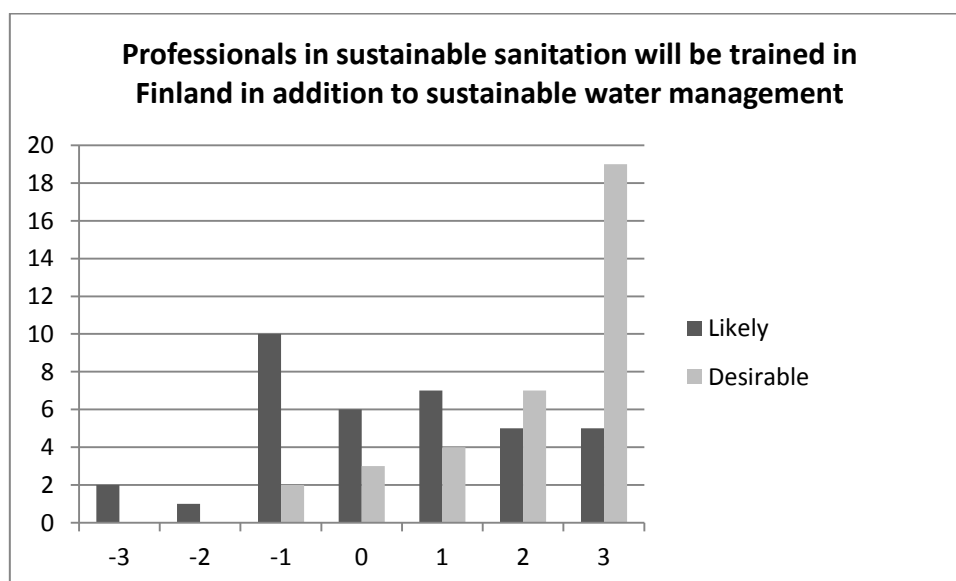


Figure 47: Professionals in sustainable sanitation will be trained in Finland in addition to sustainable water management: 1st round.

“If we want to address the future challenges, then we should start this right away and not wait until some fertiliser act has been changed.”

“Hopefully, education will at least become more extensive and better.”

“This education must concentrate on both domestic needs as well as exports, and hopefully a lot of women will participate.”

“Sustainable water management is a new field of education. Sanitation professionals will be trained surely more and more.”

It was also claimed that “School gardens and a curriculum on nutrient recycling and food production will be everyday practices in kindergartens and primary schools” (Figure 48). Even though signs of this sort of activity are showing already, the experts did not believe the practice would become wide-scale.

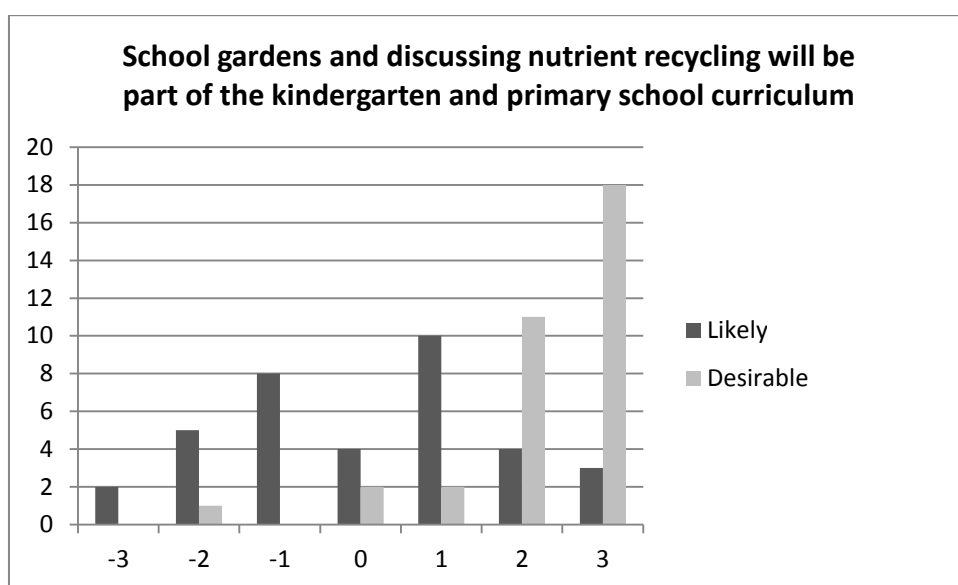


Figure 48: School gardens and discussing nutrient recycling will be part of the kindergarten and primary school curriculum: 1st round.

“There are clear sign of this already – interest is increasing and activities being organised.”

“It would be necessary to include this in the basics of the curriculum; otherwise it will not become a general practice.”

It was also suggested that there would be a professor of sanitation in a Finnish university (Figure 49). This divided the votes rather evenly on the likelihood, while many considered this desirable. It was also noted that there are universities where sanitation is studied, even though no professorship is solely focused on sanitation.

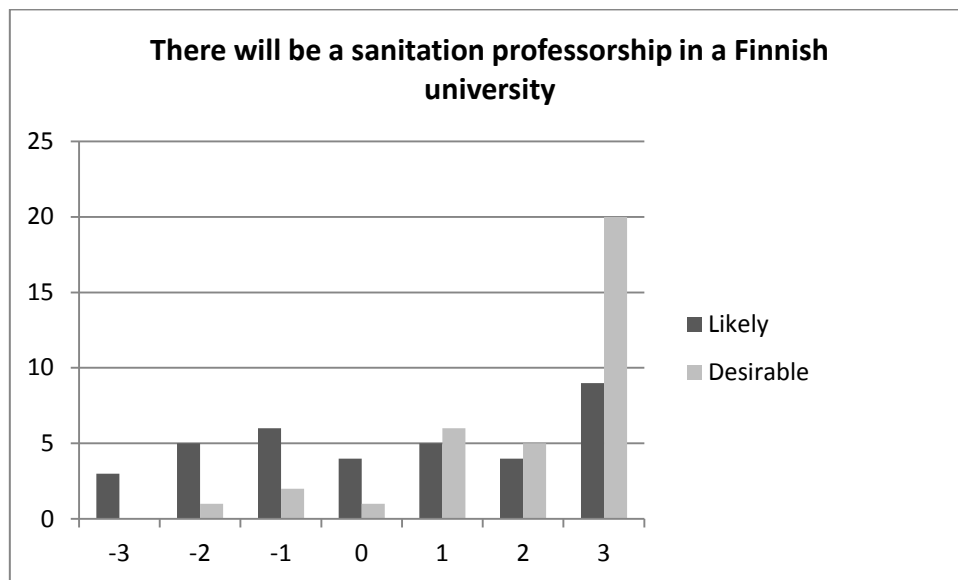


Figure 49: There will be a sanitation professorship in a Finnish university: 1st round.

“In the University of Jyväskylä, sanitation is included as one field, but there is not a professorship focusing only on sanitation.”

“I think this will happen quite soon.”

To continue the theme of education, it was also claimed that “Construction and housing engineers will know dry toilet technology and be able to recommend equipment for households (new or renovation)” (Figure 50). This was not considered very likely at all, but it was a desirable outcome.

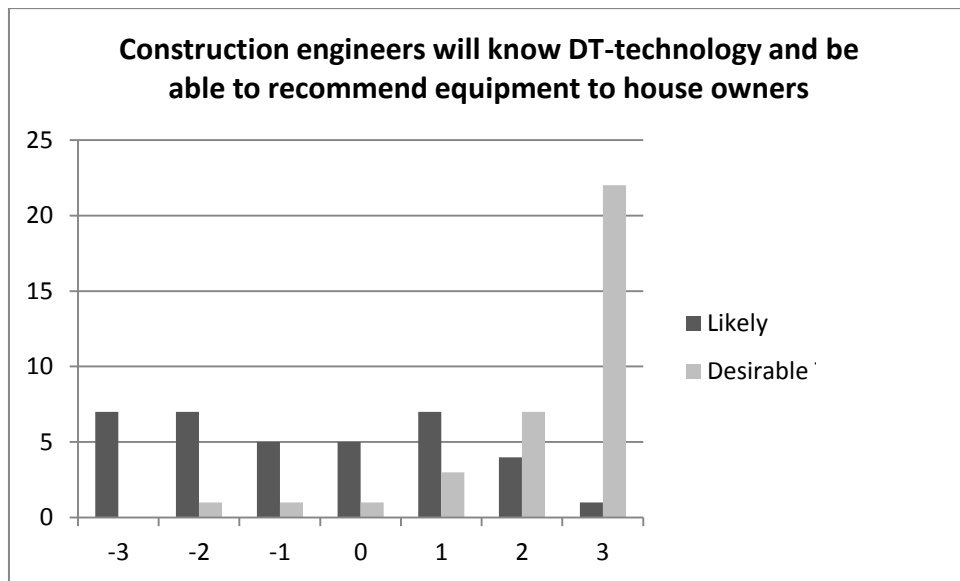


Figure 50: Construction engineers will know DT-technology and be able to recommend equipment to house owners: 1st round.

“If the market economy finds a way to make money out of it, then it is likely, but otherwise not!”

“Houses will be sold as packages which include wastewater treatment facility. Dry toilets will be for those who want it (hippies) and those who can’t otherwise have a flush toilet (water supply, permits).”

“This is probably the most difficult attitude change: industry and professionals of certain fields benefit from the current system.”

“This will take time, but when policies are turned around and this becomes a beneficial enterprise, then the professionals will follow.”

The second round claims put together the remarks from the first round. A claim stated that “Sustainable water and wastewater management is a new educational field. Sanitation professionals will be trained more and more” (Figure 51). Expressed in this way, the experts found it more likely than in the first round.

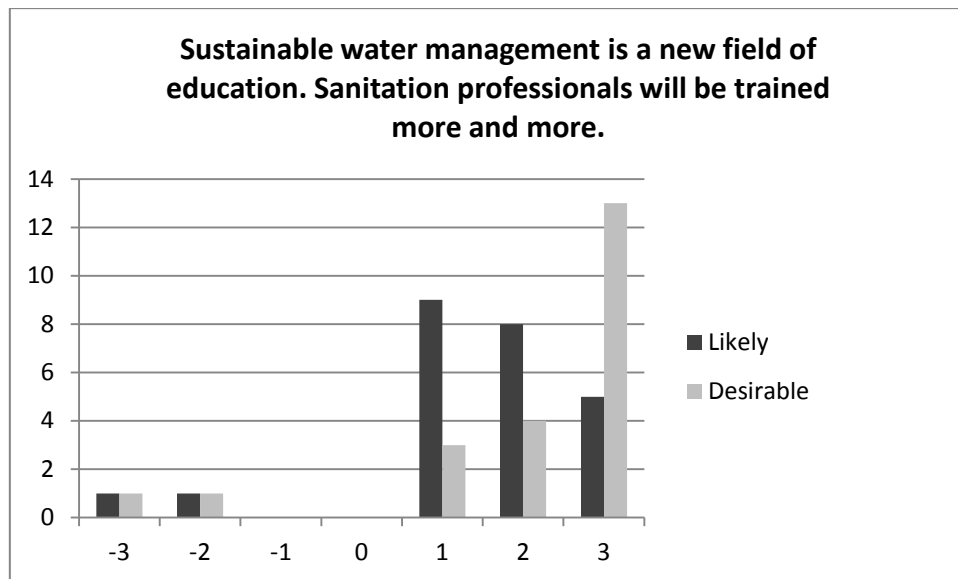


Figure 51: Sustainable water management is a new field of education. Sanitation professionals will be trained more and more: 2nd round.

“Sanitation education is good to be included in current degree programmes but as a field of its own. What kind of employment would these people find? Does Finland have to educate people to work in developing countries?”

“There are more important problems in the world than the nutrients of piss. With a narrower framework many people can be hired to take care of business.”

Many commented that such education is already available – although not as a separate entity.

Also spurred by the comments of the first round, the experts were challenged in the second round by the claim that “Households will move to closed cycle wastewater systems, which will increase energy demand and maintenance problems compared to old systems” (Figure 52). This somewhat provocative claim made the remaining experts defend closed cycle systems at least on a household level. There were still a few views against fully closed cycles, but most of the experts did not see a problem: according to their comments, energy need and maintenance would not increase.

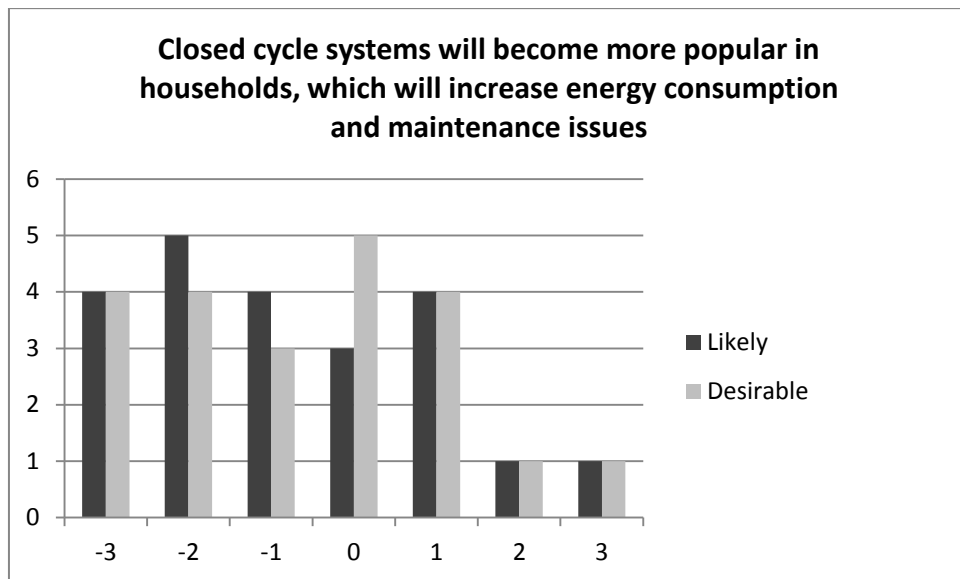


Figure 52: Closed cycle systems will become more popular in households, which will increase energy consumption and maintenance issues: 2nd round.

“There is no point moving to closed cycles in Finland because it causes difficulties and risks. Perhaps in some countries where there is lack of water.”

“The trend to conserve energy must be stronger and does not support this. The willingness to pay for maintenance, for anything, is quite small and does not support complex devices.”

In the cross reference figure it can be seen that especially representatives of the agricultural and business groups find an increase in energy demand and maintenance likely (Figure 53).

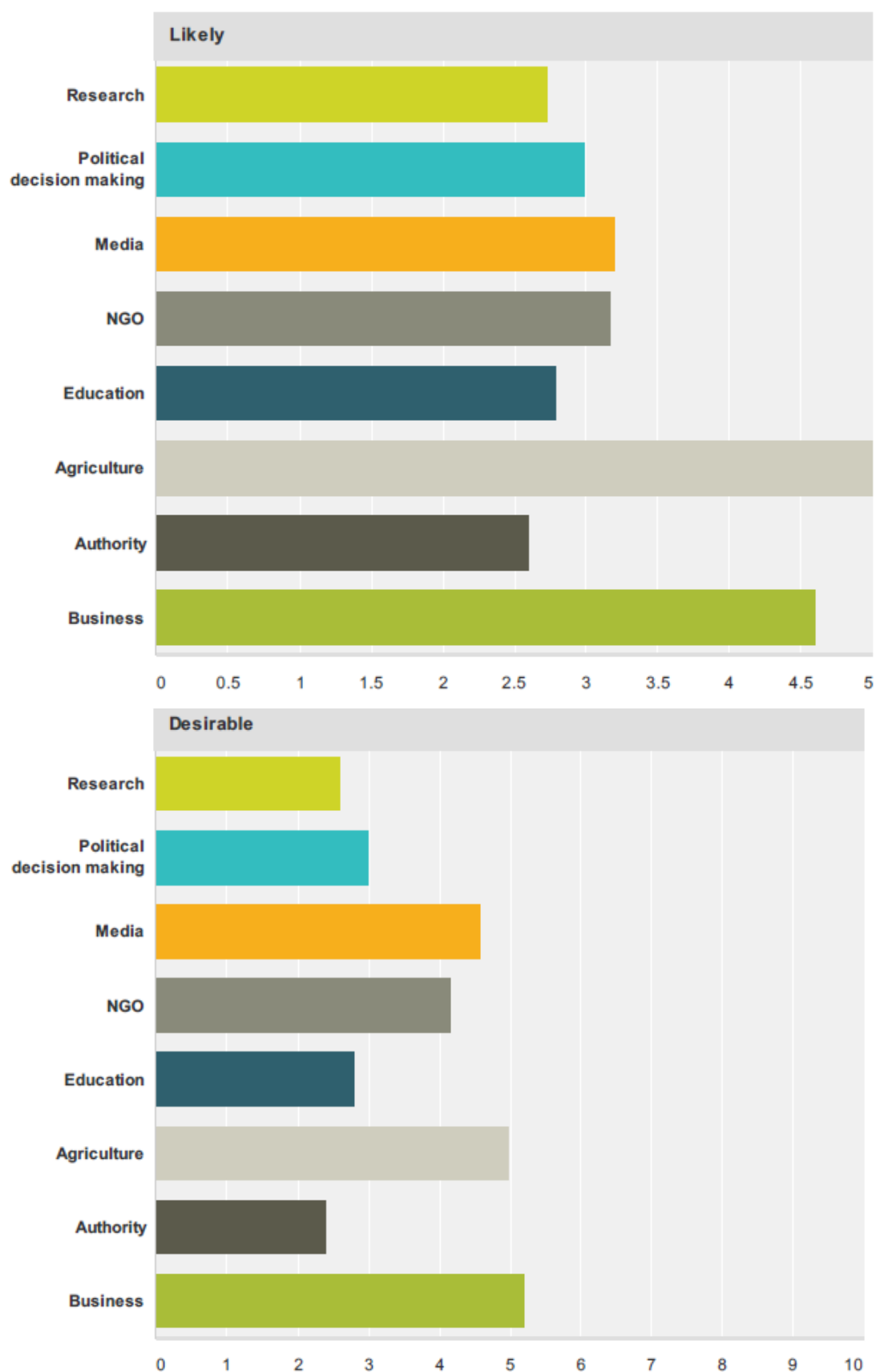


Figure 53: Closed cycle systems will become more popular in households, increasing the energy consumption and maintenance issues. Cross reference between occupational groups: 1st round.

To address the sanitation crisis in the world, the second round suggested more flush toilets for meeting the need (Figure 54). This was clearly not a desired outcome for the experts, although the likelihood of such happening seemed to be difficult to predict.

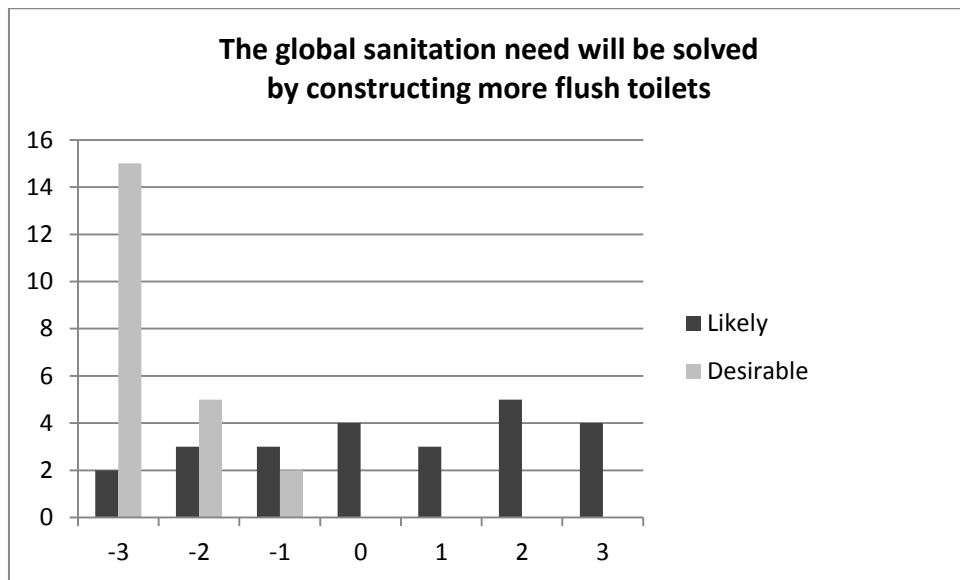


Figure 54: The global sanitation need will be solved by constructing more flush toilets: 2nd round.

“Also in the poorest countries the flush toilet is the goal. Currently available alternative models require extra effort and interest in one’s own excreta treatment. People’s hobbies in developing countries are moving to another direction. Easily maintained technology is required in order for the flush toilet not to be the only option.”

“The flush toilet is still considered as a sign of wealth, and changing that attitude globally can be challenging.”

“Hopefully not, at least in countries that have poverty. In big cities the hygiene aspect of sanitation requires a centralized system.”

Finally, the last claim of the first round covered the views on attitudes. Since most of the comments reflected an issue with attitudes, it was interesting to see the

experts' reaction to the final claim: "Negative attitudes and prejudice are the biggest challenge for implementing closed cycle systems" (Figure 55). It turns out that negative attitudes seemed to be the biggest issue and this was seen as a difficult challenge to tackle.

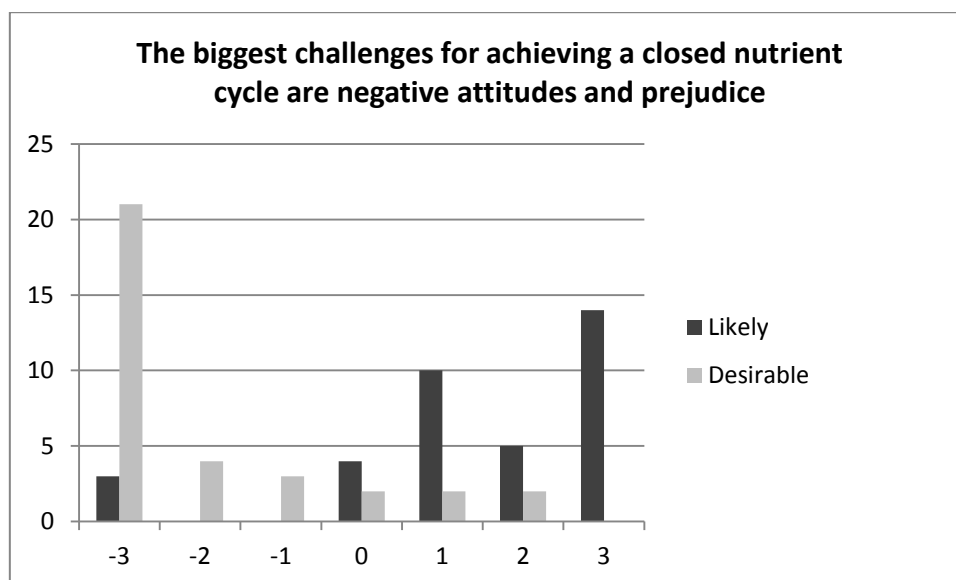


Figure 55: The biggest challenges for achieving a closed nutrient cycle are negative attitudes and prejudice: 1st round.

“Hopefully, negative attitudes will slowly diminish. This can be done by increasing research, developing legislation, etc.”

“Children can be brought up to consider this matter as a positive thing and the adults’ attitudes will change through them.”

The same question, when cross referenced, indicates that there seems to be a consensus between the groups regarding this matter; the main challenge when discussing nutrient recycling lies in people’s attitudes and prejudices (Figure 56).

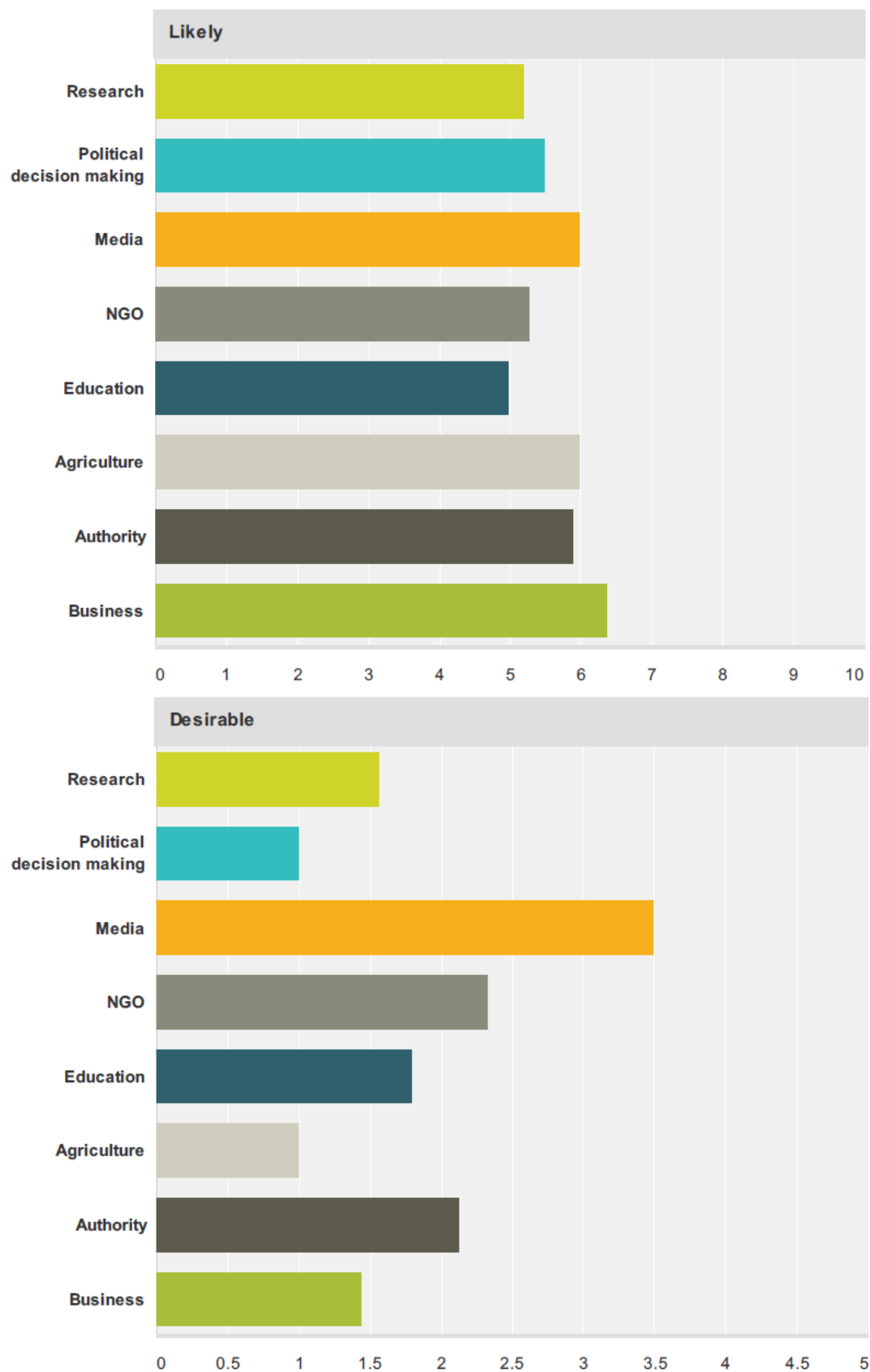


Figure 56: The biggest challenges for achieving a closed nutrient cycle are negative attitudes and prejudice. Cross referenced between occupational groups: 1st round.

6.2 Initial findings

On the whole, the questions were considered challenging, but also appropriate. Most of the experts found that the correct topics were tackled, while some found the unclear statements unnerving. It is true that some questions were multifaceted and complex, which was a conscious choice after pre-assessing the questions with a test group⁴. Being able to define the question themselves and clarifying it in the comment field is one of the advantages of the Delphi method, and, indeed, many experts used this option to clarify and argue their responses. More concentration was hoped for on the financial aspects, while some respondents did not see this as “a real issue”.

In short, the survey compiled a list of important steps that need to be taken and challenges that must be tackled in order for ecosan to emerge. It was still pleasing to notice that the majority of experts did consider ecological sanitation as a feasible option, often one solution amongst many, and the need for further research is therefore great.

The survey was compiled within a tight schedule but yet, by involving actors from relevant sectors, it did shed light on how the experts view the current status of ecological sanitation, as well as the potential future prospects. The two round online panel with an opening seminar and an end lecture was fruitful and yielded several results, and although it is possible that more thorough results could have been achieved through a third round, further issues were not brought up by the experts. Nevertheless, this survey gave prominent results which will be useful in further study of the theme. Further implications of the Delphi survey are discussed in section 7.2.

⁴ The test group included the two individuals organising the first seminar in April 2013, as well as two other test subjects; they did not take part in the actual Delphi.

Paris throws five million a year into the sea. And this not metaphorically. How, and what way? Day and night. With what purpose? None. With what thought? Without thinking about it. For what use? For nothing. By means of what organ? By means of its intestine. What is its intestine? Its Sewer...

...

There is no guano comparable in fertility to the detritus of a capital. A great city is the most powerful of dung producers. To employ the city to enrich the plain would be a sure success. If our gold is manure, on the other, our manure is gold. What is done with this gold, manure? It is swept into the abyss.

At great expense, we send out convoys of ships, to gather up at the South Pole the droppings of petrels and penguins, and the incalculable element of wealth that we have at hand we send to the sea. All the human and animal manure that the world loses, if restored to the land instead of being thrown into the water, would suffice to nourish the world...

...

A sewer is a mistake.

Victor Hugo, *Les Misérables*, 1867

7. Assessing the futures of ecosan

To concentrate on the challenges on how ecological sanitation could become a feasible and more widespread option, it is necessary to assess the cases introduced beforehand – and with the risk of generalising the results from the case studies, this chapter considers the development of ecological sanitation globally, into a new norm as a part of a modern toilet institution.

7.1 The case studies

In Chapter 5, four case studies were described, portraying a picture of what the status of ecological sanitation is in the selected countries. A brief overview of the cases is as follows:

Finland: An industrialised country with flush toilets as a norm, infrastructure in place in cities and even smaller towns, only rural areas remain partly unconnected. Legislation requires adequate sanitation and the guidelines have recently included also dry toilets. Use of human excreta as fertiliser is generally not allowed, although treated sludge is used with restrictions, and more research is required in order to change the legislation, which is affected also by EU directives to some extent. The dry toilet as a concept is a common solution especially in holiday homes, and modern indoor dry toilets are available in shops. There is active promotion of ecological sanitation; also development cooperation projects have implemented ecosan projects.

Zambia: A developing country, which has a poor, although improving sanitation coverage. Especially rural and peri-urban areas are affected by poor or non-existing sanitation, and open defecation is also commonly practiced in rural areas. Cities have sewage networks in place, and wastewater is treated – and treated sludge is sold to be used as fertiliser. Several development cooperation projects include the

aspect of ecological sanitation, and although the concept is still somewhat taboo, communities have started to accept the sanitation/fertiliser combination. Agriculture is an important livelihood to many and fertilisers are expensive – animal manure and human excreta are used on fields, although largely in secret. The legislation follows Western views on sanitation, but implementation is not done as planned due to a lack of resources and capacity. A decentralisation process is still under way, although officially completed. Ecological sanitation is neither forbidden nor encouraged, but decision-makers are slowly starting to see it as a feasible option. The flush toilet is still considered the desired sanitation option.

Ethiopia: A developing country with a relatively poor sanitation situation, especially in rural areas. The government has actively attempted to improve the situation, but resources limit the implementation. National policies have been developed to include sanitation, but the concentration lies still on water issues. Civil society is actively promoting ecological sanitation and projects have been successful in communities. The policies or legislation do not mention ecological sanitation specifically, although the authorities have found it a feasible solution and are supporting it – whenever they are aware of the option. Often the lack of knowledge and low capacity prevent larger changes taking place; instead, the sanitation development is slow.

New Zealand: An industrialised country with the majority of people living in cities, where infrastructure and sewage facilities are in place. In rural areas, septic tanks are mainly used. Due to its geographic location, the country is prone to natural disasters, such as earthquakes, which may disrupt the water and sewage network. When affected, the citizens are equipped with chemical toilets, but there is a need for a more sustainable option. Ecological sanitation has been slowly introduced to the people, with positive reactions; however, it is only considered as an emergency option. Potentially, dry toilets could replace the old fashioned long drops in camp sites and rural areas, but in cities the WC is still the norm. The legislation does not prohibit the use of human urine or compost in gardens or fields, and there is awareness of the importance of nutrient recycling – although not enough information on ecological sanitation.

In Chapter 5, a brief account was also made of the global sanitation situation, especially in terms of ecosan, in Europe, Asia and the Americas.

7.1.1 The common ground of the cases

There was something which all the cases had in common. *Without generalising too much, it can be noted that the state of adequate sanitation is poor in developing economies and sufficient in industrialised ones. Ecological sanitation has been introduced (or, to be more correct, re-introduced) to some countries by local or international NGOs, and usually the communities welcome the solution. The legislation, if existing, monitors the use and treatment of sewage sludge, but generally does not mention composted human excreta or separated urine. The idea of nutrient recycling is ancient in most countries, but today it is often seen as unhygienic. Thus, more research as well as sensitising people to the concept is required.*

Overall, people still yearn for the global norm, the white porcelain flush toilet. Even if other types of sanitation facilities are being implemented, they are considered as temporary solutions, as the thought pattern often follows the sanitation ladder, where the flush toilet is the peak of sanitation development (UNICEF 2008b). Based on previous research as well as the findings in this one, the general attitudes are clear: the flush toilet is the correct type of toilet which should be aimed at, and everything else is secondary – including ecological sanitation. In industrialised countries it is an option for special circumstances and environmentally conscious people; in developing economies it is a good option while waiting for the flush toilet (and, eventually, sewage network). (van Vliet *et al.* 2011.)

Even though experts condemn the current flush toilet for both wasting clean water as well as flushing away valuable nutrients, the common conception of the dry toilet has not changed. In some cultures, water is a key element in a toilet as it is customary to wash instead of wipe. Low flush toilets and pour flush latrines are suitable methods, but they are usually not enough for people whose minds are locked into one kind of “correct standard”.

It is challenging to change an established institution. As Jepperson (1991) reminds us, there are four types of institutional changes: institutional formation, institutional development, deinstitutionalisation and re-institutionalisation. Institutional formation is an exit from social entropy or from non-productive behavioural patterns. As examples, Jepperson uses, respectively, the institutionalisation of the self, differentiated from nature and gods, and

institutionalisation of sexuality. (Jepperson 1991.) Institutional formation can also be used to describe the institutionalisation of sanitation; when it was understood that toilet waste cannot be stored in towns; when the flush toilet was found to be the “cleaner” option; or when sanitation was declared a human right (Nygård 2004; United Nations 2010; WHO 2012). The institutionalisation of sanitation and, as a separate matter, the institutionalisation of the flush toilet, has drilled the white porcelain deep into the common global culture.

7.1.2 Institutional change?

Sanitation as an institution is naturally a good thing; it is positive that the matter is finally taken seriously also on the global level, and not being silenced due to shame and discomfort. In the case of sanitation, it is not necessary to talk about deinstitutionalisation or even re-institutionalisation into another institutional form around different principles or rules (Jepperson 1991). In fact, it is still important to maintain the sanitation institution and even the flush toilet; it is simply time to develop the current institution onto a more sustainable course.

When talking about the feasibility of ecological sanitation, we are much more likely to look into institutional development. This elaboration of institutions stands rather for institutional continuation rather than an exit: to create something new, to formulate the existing institution. (Jepperson 1991.) It is not likely that institutions will change quickly; institutionalised structures and behaviours tend to change more slowly than those that are not (DiMaggio & Powell 1991), but there are still ways for institutions to change. Institutions can develop contradictions with their environments – this took place with the success of the environmental movement – or with social behaviour. These contradictions, or environmental shocks from outside the institution, can cause institutional change by either blocking reproductive procedures or supporting the successful completion of those procedures, thus modifying the institution. Internal change is also possible; sometimes institutions drive changes by themselves, often by routinizing social change. (Jepperson 1991).

One way for institutional change to occur is due to coercive isomorphism. This results from formal and informal pressures on the institution; it can be legislation or other government mandate to adopt new (e.g. more environmental) methods; it can

also be caused by the cultural expectations of a community or be influenced by organisations such as NGOs. (DiMaggio & Powell 2011.) This is also something that can be linked to both the cases above, as well as the key elements of World Polity Theory.

World Polity Theory (WPT) explains partly which factors influence the change of institutions, which reasons cause states to choose new action patterns, and why new reforms are being adopted or discarded. (Alasuutari 2011a.) When studying the cases, several things that support World Polity Theory can be picked out. First, the development of sanitation is often due to international organisations, IGOs and NGOs. The UN declaration of sanitation as a basic human right (e.g. United Nations 2010) is definitely one strong example of how organisational actions push ideas onto states and make them comply. But also before that progress was made, NGOs, in conducting development cooperation projects, saw the need for sanitation and many of them brought in the ecological approach to ensure the recycling of nutrients. This influenced governments, much like in Zambia and Ethiopia, to comply not only with sanitation targets, but also this “new” idea of sustainable sanitation and nutrient recycling.

The development can be witnessed also in industrialised countries, where knowledge of more sustainable practices has spread due to research and international organisations’ promotion of ecological sanitation. When enough information is given on a matter, the states must look into it. It is also often a matter of finance, as it is with nutrient recycling. Diminishing phosphorus resources require all nations to investigate options for recovering phosphorus from wastewater – as well as using other methods. World society is facing a general lack of resources, which influences all states to employ new models. This is the external push that the flush toilet institution requires for making potential change.

The change is likely to be ignited by NGOs and IGOs – this is already taking place as attitudes towards ecological sanitation practices are slowly changing. The implementation of change is for governments to take care of; the changes in policies have already been made in many countries to encourage people to carry out nutrient recycling and sustainable practices. Developing countries have the option of skipping one phase of development and moving straight into sustainable sanitation when reaching for full coverage. The policies and legislation in turn will affect

practices – the sanitation institution itself – which will change slowly. But once the new practices become routine, the change can be considered successful.

7.2 The Delphi survey

The Delphi survey described in Chapter 6 gave some insight into how the Finnish experts find the development of ecological sanitation: in Finland as well as globally. Their thoughts pointed out some general issues as well as details of what still needs to happen in order for institutional change to occur.

In this section, the key aspects of the survey will be analysed in the light of methods used in futures research. The Delphi survey indicated a development in the scaled responses of the experts: based on the levels of development, the future scenarios were drawn to emphasise fast and slow development, varying in different sectors as indicated by the survey. Here, the environmental scanning method is used to point out the driving forces, megatrends and weak signals pointed out by the experts, which will then be drawn into images of the futures by using the Field Anomaly Relaxation (FAR) method.

7.2.1 Expert findings

As presented in the previous chapter, the experts gave some valuable insight into how they feel sustainable sanitation will be developed – from a Finnish perspective in this case. Some key findings based on the survey showed that there is a need, and at least partial will, for more sustainable practices, but great doubt on whether the market economy and political will recognise this need.

According to the experts, in the future there will be more closed cycles in all aspects. As there is a risk of food shortage, so food production must be secured. However, organic fertiliser is unlikely to become more common until the fertiliser industry becomes interested – this, in turn, requires shortage of mineral phosphorus and peaking of prices. In other words, organic fertiliser will only be used once, and where, it is needed. The experts agreed that fertiliser prices will peak – sooner or later - and will act as a driving force towards more sustainable sanitation practices. A general strategy on diminishing phosphorus resources will be drafted soon,

hopefully even by 2020. Many of the experts share the concern that urine and composted fertiliser might require tighter standards than other fertiliser products; but this should not be the case, they say.

In terms of the safety of humanure and urine use as fertiliser, it is likely that pharmaceuticals and hormones will continue to cause problems in aquatic ecosystems. It is unlikely that the pharmaceutical industry will start developing fully biodegradable drugs.

Technological development is called for in several of the experts' comments. More easily maintained technologies are needed, although, according to some, the current technologies are already quite simple and require low maintenance. Energy saving is a big trend in industrialised countries, and some say ecological sanitation might consume more energy. This claim, however, did not reach a general consensus amongst the experts. In developing countries especially, the trend is towards saving water resources, which can be done by using dry toilets, low flush toilets and recycling grey water. Still, it is likely that flush toilets will increase globally.

In short, the biggest issues are related to people's attitudes. The ideas of ecosan as an unhygienic practice as well as the concerns about the use of human urine and composted excreta as fertiliser push many away from the concept of sustainable sanitation. Imagining dry toilets as smelly outhouses is a common misconception that increasing research and best practices might be able to tackle. The experts believe that, e.g. waterless public toilets could very well become more common if they can be maintained in an odourless and clean state.

7.2.2 Further findings

After examining the case studies as well as the opinions of the experts, it is time to further consider the future aspects of sustainable sanitation. In the light of futures research, it is possible to identify trends and weak signals emerging from the current situation.

It is relatively easy to spot some general trends that could be linked to ecological sanitation. *Ecological thinking* and *environmentalism* have been on the increase for a while, and people are more interested in the state of the world and the

environment. The shared concern for the state of the environment guides people to choose more environmentally friendly products, methods and ways of life.

In terms of sanitation, there are some phenomena that could be categorised as *megatrends*. In recent years, the issues of water treatment and pure drinking water have increased their importance in people's lives, and they have received a great deal of media attention. This could be partially a result of the Millennium Development Goals, launched by the UN in 2000, which have brought to people's attention the most crucial aspects of global wellbeing. It was not until 2013, however, that sanitation has reached the status of what might be referred to as a megatrend. The UN declared sanitation as a human right and confirmed the 19th November as World Toilet Day. (UN News Centre 2013.) Sanitation seems to be catching up with water in development issues, and perhaps soon more people will realise its importance. This can be deduced also from the policy documents drafted in several countries, including the four case countries in this research. Increased effort in sanitation practices and the sustainability aspect can be detected in many of them, Ethiopia being a good example of encouraging policy development.

The expert statements also suggest that diminishing phosphorus resources will become a big issue in the future. So far, countries have not widely acknowledged the situation, but this could be considered a *weak signal*: the signs are there for a phosphorus peak and the need for P recovery to become a megatrend in the near future (or it already has become one – it depends on which expert you ask). The EU is already looking into it, and now it is up to the media to raise the topic into a more public discussion. Phosphorus is on the verge of turning from a weak signal into a megatrend.

Other weak signals can be detected when studying the media. Ecological sanitation has made an appearance in some big newspapers. While sanitation has been a popular topic for a while now, ecosan is still an unknown aspect often related to smelly outhouses and unhygienic farming practices. Yet, increased discussion on modern dry toilets for indoor use and especially the interest in including ecosan as a part of development cooperation projects suggest that the topic has aroused some interest. Ecosan is still a far cry from becoming a megatrend, but the signs are there; we have a weak signal.

Another weak signal, perhaps, could be the growing movement in civil society. The role of civil society is important in achieving any changes, but especially when

concerning environmental matters. Sanitation is not seen as a great business opportunity, so voluntary effort from NGOs is required to bring ecological sanitation forward as an option.

There are some aspects which might be considered as driving forces for the increased development of sustainable sanitation. The idea of sanitation as an institution can be considered as one: it is difficult to address the norm of a flush toilet and bring new ideas into the mainstream. In general, institutions can be seen as driving forces themselves to certain extent, as they form the way people behave and think, the way societies function and they set the norms we approve of. It is, then, necessary to affect the institution by utilising the emerging weak signals and megatrends.

In order to determine what needs to happen in order for ecological sanitation to become a feasible option, it is necessary to develop some futures paths and scenarios.

7.3 Potential futures

Based on the case studies as well as the Delphi survey in thematically analysing the data, four scenarios have been identified for potential futures. It is necessary to point out that the scenarios are not likely to occur as portrayed here, but instead are possible outcomes – the future is likely to be a mixture of all of them, or nothing like any of the scenarios. Based on the mind map (Figure 5), as well as the expert interviews in both Delphi survey and the case studies, it is possible to determine the most important variables.

The futures table (Table 6) is drawn up based on suggestions derived from the material mentioned above, and is then categorised with the help of the PESTEL framework into 6 *sectors*: political, economic, social, ecological, technological and legal. The PESTEL framework enables the examination of a phenomenon through certain points of view. To identify varying outcomes for sectors identified in PESTEL analysis, it is possible to obtain an overall view of the potential futures. The outcomes themselves are a result of the analysis of the case studies and expert comments, and do not by any means represent a conclusive set of potential futures. It is also possible that some sectors have been overlooked outside PESTEL, but it

has been attempted to include here the most important aspects raised in the research thus far.

The four *states* (the *State* row in Table 6), on the other hand, were determined by the expert views in the Delphi survey as well as the interviews. According to the FAR method, the data was first gathered and analysed, and the futures table (Table 6) was constructed by identifying the important aspects of the variable sectors – determined by the PESTEL framework (the *Sector* column in Table 6). Based on the table, images of the futures are drawn to form snapshots of potential futures, which in turn can be connected into futures paths.

The potential outcomes were divided into four possibilities – or *states*: A) ecological sanitation is strongly adopted by the world society in every sector, B) slow progress towards more sustainable practices is happening, C) development is brought on by necessity, and D) sustainability in nutrient recycling and sanitation is forgotten and good practices deteriorate.

Out of the futures table, it is possible to identify different images of the future. Before that, impossible pairings must be recognised, as not all outcomes can possibly occur at once: for instance, legislation cannot at the same time both allow and forbid the use of humanure (except in different countries, but here the futures images are considered from a more general world society point of view). Once the images of the future are recognised, futures paths are formed to identify the development from one image to the other. As previously indicated, the outcomes are derived from the expert comments and Delphi scales, indicating factors that may be important for a new domestication process or adoption of a change.

The outcomes, i.e. the images of the future derived from the futures table are:

AAAAAA: Balanced world society

BBBBBB: Current development continues

CBBCBB: Money talks

CCCCCC: Standing still

DDDDDD: Deteriorating society

Table 6: Futures table

State/ Sector	A	B	C	D
1. Political -sanitation policies	World society is pressing towards ecosan	Countries find it challenging to adopt global rules	There is no consensus on how sanitation should be tackled	Sanitation is not a priority
2. Economic -P resources	Economically sustainable methods are favoured	Some countries have prepared for diminishing P resources	Organic fertiliser is taken into use as need grows	Food production is wavering due to lack of P
3. Social -need for sanitation	Adequate sanitation is within everyone's reach	Development cooperation continues for sanitation improvement	Countries are in charge of their own sanitation situation, success varies	The amount of people without adequate sanitation grows as population grows
4. Ecological -nutrient recycling	Majority of nutrients are recycled adequately	Aquatic ecosystems are in better condition	Nutrient recovery systems are being developed	The state of ecological deterioration continues
5. Technological -toilet solutions	Modern, sustainable and easily maintained toilets increase	Dry and low flush toilet solutions are being developed in industrialised countries	Developing countries work on affordable latrine models with the goal of a flush toilet	Inadequate sanitation practices spread, including open defecation
6. Legal -fertiliser use	Human- originated fertiliser can be used and treatment methods are monitored	Carefully tested "humanure" can be used for certain crops and fields	Human waste, mainly sludge, is used for landscaping and forestry	Due to epidemics, human-based fertiliser is banned from use

To understand the relationship amongst the identified images, Figure 57 below represents the futures paths on how the images will change from one scene to the other. When these futures paths are then studied, various scenarios can be drafted. These scenarios, which represent potential futures and not any one future in particular – the actual future is likely to be a combination of the said scenarios, or something quite different – do shed some light of what might happen, or what would

need to happen in order for ecological sanitation to become a more feasible option. In the scenarios, case countries are not singled out, but outcomes are discussed with regard to industrialised countries and developing economies.

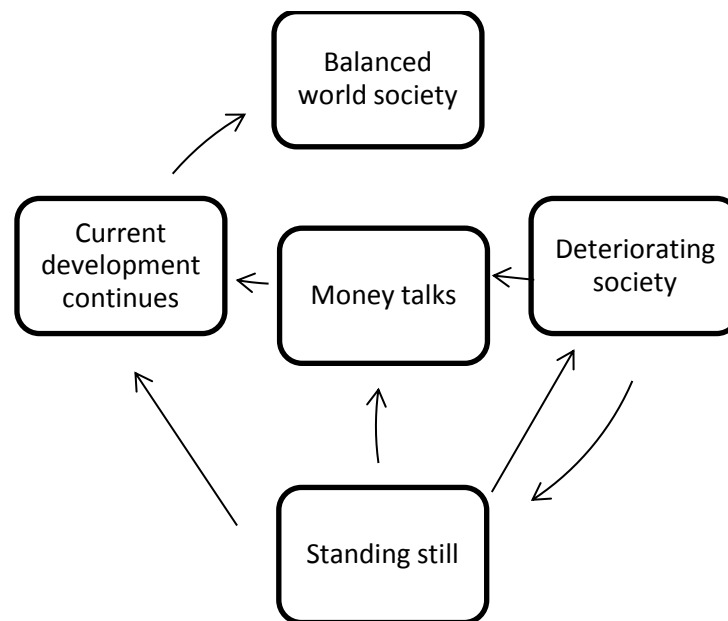


Figure 57: Futures paths.

7.3.1 When you gotta go...

The first scenario described here reflects especially on the views of the experts from the Delphi survey. The idea that nothing will happen unless there is a necessity, is a strong catalyst here.

The scenario builds on a futures path, where, starting from development standing still (CCCCC), there is no interest in investing in sustainable practices. Around the world, mainly in the developing countries, organic fertilisers are used more and more, but the fertiliser industry itself is not interested. In industrialised countries sludge is used in landscaping, but hardly anywhere else, and legislation on this matter varies from country to country. Some states are looking into more sustainable practices, but the trend is still towards artificial fertiliser. There is some fear about

making new investments as the economic downturn does not support new, potentially high risk ventures.

The world's sanitation situation remains unresolved. The developing countries are still looking towards flush toilets as the norm and the desirable goal, whereas millions and billions of people still have no access to adequate sanitation.

However, as it slowly becomes clear that phosphorus is reaching its peak and that it needs to be recovered from wastewater, alternative technologies are slowly being developed. Attitudes are slowly softening towards humanure and urine use, as the media report successful trials and new technologies being developed. Dry toilet solutions are being developed further, but also nutrient recovery from wastewater is reaching new solutions. In developing countries, dry toilets are built in rural areas and ecological sanitation practices are promoted by local and international NGOs. The development continues (futures path BBBBBB) as attitudes soften and give way to new ideas.

7.3.2 Practice makes perfect

In the second scenario, the current development continues (futures path BBBBBB) and the decisions made at country and international level are supported. There is strong determination that the MDG – as well as post-MDG and SDG goals (Millennium Development Goals; Sustainable Development Goals) – should be met and the amount of people living without adequate sanitation should be at least halved. Development cooperation projects implement ecological sanitation and other sanitation practices together with their core activities and sanitation is addressed by NGOs as well as governments – also the private sector tries to do its part in improving sanitation conditions in developing countries.

New technologies are being developed and tested, more research is being conducted and the results are encouraging. Organic fertiliser use has become more popular as the practice is deemed safe by several food and agriculture authorities. The need for nutrient recovery has been identified and plans have been made for tackling the challenge – one action step includes organic fertiliser and even reuse of humanure and urine. Human excreta – after composting – as well as separated urine

are being collected wherever possible and used as fertiliser in fields, gardens and forests. Also the potential for energy use of human waste is being studied further.

The toilet itself is slowly changing: the flush toilet no longer is the absolute norm but more models have been designed to meet the needs of ecologically aware consumers. Various models of indoor dry toilets are slowly finding their way to households in rural and ultimately also urban areas, and new houses are always built with low flush or vacuum toilets. Public buildings are set up with dry toilets – at first as a trial but slowly the cost savings are being noted by decision-makers. This leads to ecological sanitation becoming a part of the school system, as it is a most cost-effective way to utilise the toilet waste in the school gardens.

Common practices are being followed within the EU at first, and later within the donor community – practices fit for developing and developed countries are being recognised and reported. The toilet norm is changing slowly towards a more accepting standard, where the flush toilet is not a necessity and more attention is being paid to the ecological impact of the system.

Organic fertiliser use also develops agricultural practices and nutrient runoffs diminish, making aquatic ecosystems less eutrophicated and purer. Research has shown the beneficial nature of organic fertiliser and monitored agricultural practices are being followed. Also small-scale producers participate in the production of organic fertiliser, from horse manure to human urine. Consumers no longer avoid organically grown produce, as the price does not vary greatly due to increases in artificial fertiliser prices.

More sustainable methods are being studied and developed, and the cause and effect relationships between ecological, economic and social wellbeing have been understood.

7.3.3 Money engine

Again, spurred by the views of the Delphi experts, this scenario emphasises the importance of money in development. Starting from the situation where the sanitation crisis and phosphorus peak are being acknowledged to some extent, still no need is seen for further actions or investments (futures path CCCCCC). More

important issues are being identified and sanitation on the whole is not considered a lucrative business.

However, some research findings have indicated the growing potential in the use of urine as fertiliser, and some companies are taking this seriously – especially with the knowledge of impending phosphorus shortage. Investments in further study of organic fertiliser are being made.

Dry toilet technology is still not considered a solution for mainstream use and the number of manufacturers remains few. However, as the economic conditions of developing countries improve, the sanitation crisis begins to solve itself. Flush toilets are being constructed in more and more households in developing countries and centralised wastewater treatment facilities are being built with the help of international companies and local work force. Urban areas are developing towards the Western model, as businesses have started to find profitable investment sources in developing countries.

The state of the environment remains constant. The growing need for fertiliser and wastewater treatment stresses aquatic ecosystems, but technological development prevents the situation from getting any worse. Ecological values are becoming more of a marketing strategy as people's environmental concern is great but they do not wish to settle for less comfort compared with their current living standards. Further research on more environmentally friendly products is being done, and recycled materials are becoming more popular, saving more money from the industry as well.

The sanitation crisis remains the problem of rural areas in developing countries, where wealth does not find the needy. Poverty and class differences are growing, and the amount of people living without adequate sanitation is not decreasing considerably despite the growing investments. Development grows as money talks, but at what price?

7.3.4 **** happens

The final scenario described here could be called the worst case scenario. Starting from the stagnant state of development standing still, there is no political will to improve matters. Business opportunities in the sanitation sector are few, and so the

sanitation work lies on the shoulders of NGOs and volunteers. Due to the economic recession, governments are cutting the budget for development cooperation and the work on sanitation is reduced severely. Climate change is affecting both the environment and the people in various countries with extreme weather patterns.

The population living without adequate sanitation is growing and due to cuts in development aid, also poverty is growing strongly. Inadequate sanitation methods and open defecation are spreading, and causing epidemics. The population is increasing in developing countries and due to climate change, food shortages are causing famine in certain areas. Also the Western countries are affected, as phosphorus is running low and the prices are high. There have been attempts to try out organic fertiliser such as human urine or excreta, but due to poorly managed practices and lack of research, several epidemics have led to a ban on organic fertiliser.

Wastewater treatment technologies are being developed, but the current infrastructure cannot sustain the growing number of urban dwellers. Sewage bypasses and overflows are becoming more common as the facilities are running over their capacity. Lakes and rivers are becoming eutrophicated and the increasing traces of hormones and some pharmaceuticals are causing hormonal problems in aquatic organisms as well as humans.

The situation is grim, and there are no efforts directed towards fixing it, as the resources have to be used for tackling the more immediate problems. Preparation and long-term planning would have been useful before arriving at this state of the world, namely a deteriorating society (futures path DDDDDD).

When written, shit does not smell.
Roland Barthe

8. Discussion

This thesis has discussed the state of ecological sanitation, its feasibility and its potential in the light of current knowledge and attitudes. The material has been collected from previously written literature on a wide range of topics related to sustainable sanitation, case studies on four countries including an overview of their policies and legislation, as well as a Delphi survey conducted among Finnish experts on ecological sanitation. The topic has been approached from the point of view of neo-institutional framework considering the toilet as an institution and analysing the potential of ecological sanitation in the light of World Polity Theory. The feasibility and future aspects were studied by using methods from futures research, including the drafting of four scenarios for future sanitation and the overall state of the world.

To discuss the matters at hand, this chapter will take up the research questions presented in the first chapter and explain what this dissertation eventually discovered.

8.1 Ecosan as a phenomenon

Ecological sanitation is an old concept, made anew in view of the need for more sustainable practices in water and sanitation, agriculture, energy, environment and so forth. As the mind map (Figure 5) indicates, several issues have an impact on the emergence and success of ecological sanitation. Sustainability often reflects issues beyond the horizon, the need to look further and wider than the problem at hand. Sustainable sanitation deals with issues including environmental degradation, social distress (the need for sanitation, potable water, hygiene), economic downturn (development of new technologies, introducing basic concepts, etc.), and many other issues presented in this thesis. This wider exploration of the topic covers research question #2: *What issues have impact on the implementation of ecological sanitation?*

However, research question #1 was more concerned with the current status of ecological sanitation: *How – if at all – is ecological sanitation made possible by legislation and policies in different countries?* This was further examined with the help of the case studies, which shed more light onto how ecological sanitation is treated in various countries. It became apparent that since Western societies are heavily reliant on water borne sanitation, there has been no need to separately discuss the use of dry human excreta – most of the legislation handled sewage sludge and its potential fertiliser use, while composted faeces and separated urine were not even considered. It could be stated that the use is not forbidden as such, but the material would have to be commercialised in order to warrant proper chemical analyses to determine the safety of the fertiliser. This makes the entire procedure often too complex for small-scale entrepreneurs and producers. It is to be noted, however, that non-commercial garden use is generally accepted, at least in the case countries of Finland and New Zealand.

Developing countries, such as Zambia and Ethiopia, are facing different types of challenges with sanitation. Large amounts of their population have no access to adequate sanitation facilities and thus improving sanitation coverage is the first of their priorities. Yet, as the sanitation institution suggests, they are easily convinced that flush toilets are the only or at least the best alternative, leaving little room for further discussion on alternative, potentially more sustainable, sanitation methods. Even though ecosan projects have been successfully implemented and positive results gained, the political will does not support the increase of ecological sanitation over the “traditional” norm – the flush toilet. This is the case, even when local practices would benefit from affordable fertiliser and in rural areas it is next to impossible to build proper sewage infrastructure, let alone efficient and reliable wastewater treatment and disposal. The political strategy papers and legislation barely mention sanitation methods or use of treated human waste as fertiliser.

All in all, it would appear that any change to the institutional norm is difficult to achieve, as countries which have already reached a certain standard of sanitation are reluctant to change their norms, and furthermore, countries which still have work ahead of them are reluctant to act differently from the general norm. There is, however, a slight chance of ecological sanitation breaking through in developing countries. First of all, there is more will to tackle the sanitation issue and create more options for the people’s wellbeing. Second, local and international NGOs

operate between grass roots level and government offices, spreading the word on successful practices and desirable outcomes. Affordable and lasting solutions are sought after, and with proper “marketing”, new methods “outside the box” could very well become more popular. Zambia and Ethiopia both share some success stories and there is the potential will to avoid the mistakes made in the West. According to World Polity Theory, the powerful impact from the grass roots level could be the force changing the global norms, or at least bending them slightly.

Another force driving the change is crisis. New Zealand is an example of a country where there is no need to improve the sanitary system as such, but somewhat frequent earthquakes and other potential natural disasters leave the current system vulnerable. New methods which respond to the need in crisis situations are being developed, and ecosan, according to some research (e.g. WREMO 2013), seems to be an acceptable solution. The challenge is, apart from the political will, to affect the attitudes which believe that the current system is the best for their needs.

Globally, it is slowly being understood that phosphorus will be reaching its peak soon. Mining will no longer be a sensible option, and new methods for the recovering of nutrients must be developed. These methods include recovery from sewage sludge and controlled fertiliser use in agriculture, but ecological sanitation can, and should, play a part in it. Especially rural areas without a sewage network need sustainable facilities for handling their wastewater. In urban conditions, the collection of urine is a feasible option for public bathrooms and buildings, but the current infrastructure does not necessarily support this. As old structures are renewed, the new needs must be considered and, if possible, met with sustainable and functioning technology.

It seems that most of the challenges faced by ecological sanitation can be narrowed down to three categories: current policies and legislation, people’s attitudes and practices. Firstly, the current policies and legislation limit the sustainable use of human produce. As technologies develop, the treatment and maintenance of dry toilets and low flush facilities becomes easier, and the policies should follow this development. At best, policies will act as guidance methods for people to change their behaviour to a more sustainable direction; however, the policies often seem to drag down the development and create unnecessary boundaries – as often remarked on by the experts in the Delphi survey.

Another point, which is also one reason behind slowly changing policies, is people's attitudes towards ecological sanitation. Lack of knowledge and prejudice can be portrayed as negative attitudes towards anything new or different. Change is difficult for people as it is, but it is also necessary to see that attitudes can be affected by policy guidance, as well as producing more information on successful best practices – the prejudice must be countered by factual information. It is also necessary to remember that policy-makers are people too, and their attitudes do affect their judgement. It is easier to go with the flow and follow the norm than make an exception and turn to a new path.

Finally, complementing the first two aspects are practices. As mentioned, policies affect attitudes, and vice versa, but it is also necessary to remember that both of these are affected by practices. If something is not allowed by law, but people do behave in that way, there are usually two options: increase the punishment for unwanted behaviour, or make it acceptable. The course of action is naturally determined by the hazardous nature of the practice – which is why it is important to document best practices. (van Vliet *et al.* 2011; Brands 2014). The role of (I)NGOs is by no means insignificant, as they document the practices, spread the word and bring information to the decision-makers. Successful practices change attitudes and policies, but the interaction works both ways: a change in attitudes or policies can encourage new practices.

Globally, locally or individually, change is often considered as negative or effort demanding solution – short term thinking allows easy solutions, when current norms and practices are maintained. As can be argued, based on the case studies as well as expert opinions, alternative sanitation practices can be applied when necessary, but their widespread utilisations can be difficult to achieve. In Zambia and Ethiopia, the sanitation situation in the nation requires action, and ecological sanitation is one option. Yet it is not the option the global norm would suggest, and thus it can be difficult to adopt. In New Zealand, it is looming crises that encourage new thinking, but even there the domestication process is far from complete. The pilot project in Wellington (WREMO 2013) is only the beginning. In Finland, dry sanitation has spread widely in rural areas – or rather the old practice has been maintained for the lack of a better option. Outhouses are accepted because they are a part of a tradition, but according to attitudes (or general policies) they do not belong in cities or

indoors. In an existing infrastructure it is, naturally, easier to follow the leading trend, that being in this case the flush toilet.

Still, ecological sanitation is spreading, based on the literature, at least in developing economies and areas experimenting with sustainable solutions. In less strict terms, ecological sanitation is practiced in several industrialised countries, where sewage sludge is treated and returned to the fields – yet legislation is not entirely approving of this method, either. In every aspect of ecosan, the spread of the practice can be prevented by the three categories.

The entire equation of how change is brought onwards (or held back) can be easily depicted in Figure 58.

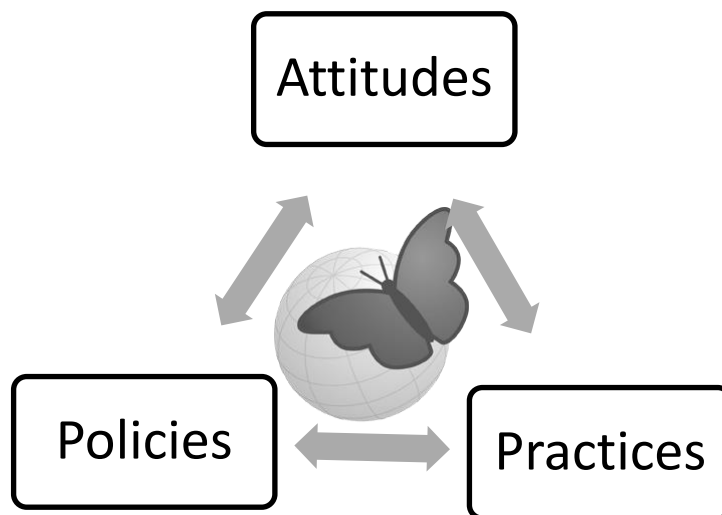


Figure 58: The impact of attitudes, policies and practices towards change.

8.2 Feasibility of ecosan⁵

The third research question of this thesis: *“How could ecological sanitation become a more feasible option as a mainstream sanitation solution?”* was to determine how ecological sanitation could reach the same popularity as waterborne sanitation. This can be estimated based on the history of the latter. World Polity Theory suggests that the domestication process becomes successful when the new norm can be harmonised with international norms and local practices (Alasuutari

⁵ Based on O’Neill (2012).

2011a). Also, even though cultural issues are important when bringing out a new idea, the main arguments stopping or advancing a new norm are interests and incentives - both on the state level as well as for individuals (Schofer *et al.* 2010).

As ecological sanitation is very close to ancient practices, where human excreta was used together with animal manure as fertiliser (ecosan simply includes the hygiene aspect), it is not as much a question of new technology being brought to people, but rather about an old practice made new - and getting the people to realise this. When proposing ideas different from mainstream concepts, the messenger has an important role. World Polity Theory emphasises the role of (international) NGOs (Schofer *et al.* 2010), and their role has so far proven to be crucial.

In developing countries, where sanitation is not necessarily a norm, it is vital to find some way of constructing safe, affordable latrines. In several development cooperation projects across the world, ecological sanitation has been introduced and thereafter implemented successfully (e.g. the Global Dry Toilet Association of Finland 2012). These are often countries where going to the toilet is a taboo; one cannot even mention the word, let alone suggest that one should grow food in the human waste - composted or not. Yet, success stories have emerged and sustainable sanitation is spoken of more than ever. In Zambia, for instance, people have used sewage sludge as a fertiliser in secret. They are ashamed to admit it, but know the benefit - the only problem is the risk of contamination. With safely treated fertiliser, even the poor can continue farming - it has even happened that the contents of a dry toilet have been stolen during the night. The voices of ecosan in Zambia have so far been NGOs, who balance between the local government and grass roots level: NGOs spread the word on best practices amongst themselves and make a noise until the governments become interested.

Obviously, the role of (I)NGOs cannot be found in the development of waterborne sanitation, as civil society had not formed earlier into what it is today. Yet, the path is clear. *Starting from grass root experiences to word-of-mouth, the practices change towards the desired end. Ecological sanitation is now at a point where experiences are shared but official guidelines are still lacking.* In developing countries such as Zambia, it is challenging to suggest methods other than those favoured in industrialised countries - as it is with the water closet: the poor want what the rich have. Thus, it would be desirable to promote ecological sanitation also in industrialised countries.

The Finnish Environment Institute (2010; see also Santala *et al.* 2011) has slowly started to promote the option of the dry toilet and recycling of nutrients in Finland. The option is still one of many and recommended in rural areas only, but the option has already found its way into official guidelines. The recommendations existed already in the 70s, but without incentives the flush toilet was a more appealing option (Mattila 1979). However, ecological sanitation and reuse of human excreta are not discussed in legislation, and interpretation of the legislation varies from person to person. Attitudes are set deep, but awareness is being raised by NGOs. Research is required to support the benefits of ecological sanitation and NGOs play an important role in spreading the new information to the people as well as to the authorities. (O'Connell 2014.)

Based on case studies from Zambia, Ethiopia and Finland, it can be deduced that practices are formed slowly: once the good experiences of a few pioneers come out, others are more willing to try the new option outside the norm. However, in order for large-scale change in practices to occur, new policies are required to support these practices. It is often found that legislative changes have an effect on practices. (Alasuutari 2011a; 2011b.) Still, the policymakers are only human and their attitudes can affect the policies brought onwards.

It is challenging enough to produce change in one state, let alone globally, but according to World Polity Theory this can be done. The theory suggests that models that support collective goods and have international organisational carriers will quite likely diffuse into a new global norm. (Schofer *et al.* 2010.) Ecological sanitation already has the support of several international (and local) NGOs and best practices are speaking for themselves. Ecological sanitation is a twist on old traditions and still provides an acceptable solution for both dry and poor developing countries, as well as modern industrialised states. It would also be beneficial to bring trade into the equation, as economic interests, as stated earlier, are one key reason for adopting a new trend – not to mention if it is good for the environment. In a way, it is surprising that more companies have not invested in it – after all, everyone needs a toilet.

Economic interests alone cannot, however, be the only reason for a change to take place, but the overall change comes from attitudes, policies and practices. For this to happen, awareness must be raised, and this is where NGOs should be the key actor. NGOs have the benefit of acting between the government and the grass roots

level: they see the practices and understand the policies (and politics) behind them. They can be in touch with the private sector as well as with academia, and thus incorporate the three pillars of sustainability together: the environmental, economic and social aspects.

When examining societies, an attitude towards ecological sanitation can be detected. Taboos come in many forms: in some places toilets cannot be spoken of or nutrient recycling is a strange concept. Others swear by water closets and perceive water as a cleansing instrument rather than a medium for spreading disease. These attitudes vary from country to country, but they do have much in common - as if they were shaped by the same cognitive models.

Yet decisions are needed in order to turn sanitation practices into a more ecological direction. Alternatives to mining phosphorus and proper management of wastewater are required globally, not to mention breaking the vicious circle of disease and death in third world countries. In theory, a globally change could occur - and in this change the role of civil society is to be highlighted.

8.3 Ways forward

This dissertation has brought up various aspects on ecological sanitation, on its benefits and challenges, and what the future holds for its feasibility. But as the fourth research question asks: *What types of futures scenarios can be found for ecological sanitation?*

Based on the analysis in this research, the potential future scenarios (Chapter 7) can shed some light on what the future will look like. But it is equally important, if not even more so, to ask *how* these potential futures will be reached. It is possible to look at ways forward by concentrating on the three categories as portrayed in Figure 59: attitudes, policies and practices.

To understand the type of environment needed for change, an excellent example is made by Lüthi *et al.* (2011) in their figure of an “enabling environment” framework. Here it can be seen how various factors form an environment where positive change is possible. Government support and the legal framework fall under policies, while attitudes cover socio-cultural acceptance. Practices such as financial and institutional arrangements, as well as skills and capacities cover the final pieces

of the puzzle which form the grounds for an enabling environment. (O’Connell 2014.)

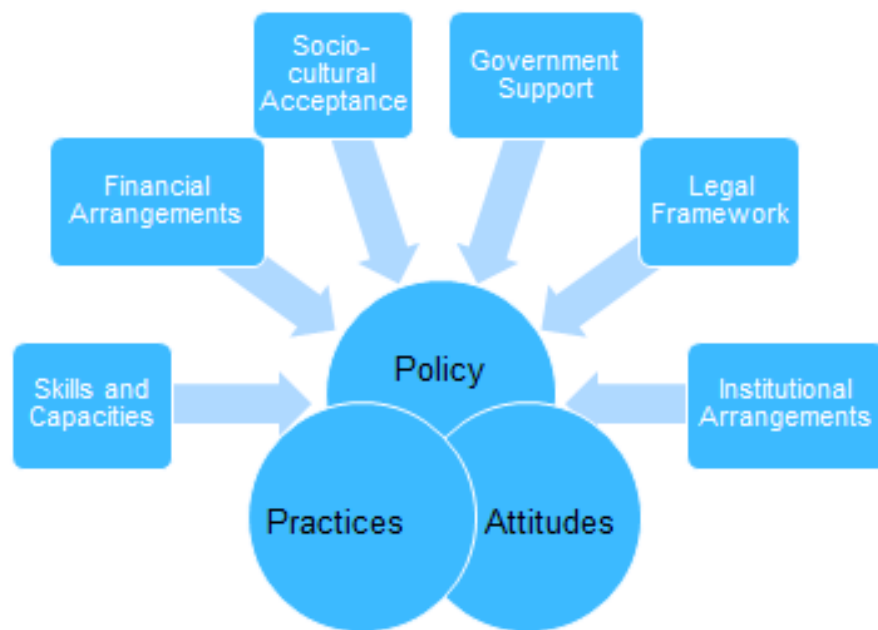


Figure 59: “Enabling environment” framework. (based on Lüthi *et al.* 2011, modified by the author).

In order to achieve an enabling environment and perhaps some of the more positive outcomes depicted in the scenarios, it is necessary to affect people’s attitudes, general practices and policies.

Attitudes are formed from early age, and some experts in the Delphi survey suggested introducing practices in schools so children could adopt new, more sustainable methods, also in sanitation. It is also necessary to understand the socio-cultural framework from which these attitudes emerge, as they vary from culture to culture. If the toilet is a taboo, it is more difficult to gain acceptance for the use of toilet waste as fertiliser, no matter how well treated it is. Meanwhile, it should be remembered that the media have an important role in creating expectations and images in people’s minds. Positive and negative reactions are often based on the first reaction to a new phenomenon and it is difficult later on to contradict the false information the public heard first. Thus, it is not only the media, but also the people spreading information who are responsible for the correctness of the facts delivered to the public. Again, civil society plays an important role here, acting as a mediator between the public and the policy-makers.

Policies, on the other hand, could very easily be changed – assuming the policy-makers have the necessary information at their disposal. It is unfortunate that much of the research never reaches the decision-making bodies, as they have no time or resources to familiarise themselves with the latest information (Laurinolli 2013). There is, in fact, a need for a mediator, and often the task falls to the NGOs and other organisations which are lobbying for their own interest. However, the lobbying is also conducted by companies, for more personal interests, and it might be challenging for decision-makers to identify factual information for a marketing speech. Furthermore, the attitudes of the decision-makers, as already stated, can form a boundary between policy and practice – personal beliefs can overcome the value of scientific research. It is also important to note that legislation cannot be changed based on weak grounds. Thorough research and sufficient need are required before legal reforms can be performed – it is easier to change future outcomes by gaining government support, at least on the policy level.

Finally, it is about practices. As far as ecological sanitation is concerned, many people globally are aware of the practice and some have even used dry toilets or human urine as fertiliser. Small-scale practices can affect attitudes – for better or for worse – but large scale practice often requires government support in order to be successful. Successful implementation of new methods also requires skilled people to conduct the work, and experts to research the conduct from an impartial point of view. New practices often need to also be financially lucrative or at least attractive in ways that will make investors willing to participate in the new practice.

An example of a good practice in terms of sanitation is Community Led Total Sanitation (CLTS), where people themselves discover the need for improved sanitation, and, with help, make it happen for their own community. In communities where the need for fertiliser is acute, ecosan has been welcomed once knowledge of safe practices has spread. In terms of financial sustainability, it has already been stated that nutrient recovery will become necessary in the near future.

8.4 Critical evaluation

Any research must be subjected to evaluation on its reliability. This is necessary especially in qualitative studies, as they cannot be as readily proven to be accurate

as quantitative research (Eskola & Suoranta 1998) and are unlike positivistic research, where clear lines can be drawn and where the results can be repeated in other research (Varto 2005). Certainly, similar requirements apply for qualitative research as well, but the difference lies in interpretation. In qualitative research, the measure of reliability is often the researchers themselves, and to some extent the sense of reliability depends also on the experiences of the reader; a more familiar topic seems more plausible. (Eskola & Suoranta 1998.) Therefore, it is necessary to provide the reader with a thorough explanation of choices made during the research process, along with reasons and process descriptions. In this study, the processes of the data collection have been explained in chapters 1.3, and 5-7. The paths between theories and methods have been explained, and the nature of hermeneutics with its spiral form process has been strong throughout the work. The data and theories have often guided the methods chosen, and the analysis has been tied to the theoretical framework. The research path has not been linear, nor entirely cyclical, but a spiral, where new findings have joined the process in every cycle.

In scientific work, it is also necessary to be able to duplicate the work to achieve the same results. In qualitative research, this is more challenging and not as straightforward due to its nature, but the findings can be affirmed by similar research examining the topics. (Eskola & Suoranta 1998.) These supporting views, along with other research material which has been collected globally, is described in Chapter 4.

When discussing case studies or phenomena which cannot be measured exactly, it is necessary to carefully select the concepts which are used in determining the reliability of the research. Plausibility and duplicability can be achieved, but it is clear that traditional quantitative science cannot be used as a reference point. Realistically, the important factor in qualitative research is how well the research target has been described in the process description. (Eskola & Suoranta 1998.) Methods such as triangulation help in forming a reliable basis for the research – to support the findings from various points of view.

In this research, its strengths can also be its weaknesses. Starting from an action research type of approach with a close network of experts participating in case studies and Delphi surveys brings reliability and supports the findings of the researcher. However, at the same time, the tight network can twist the findings to its own views, confusing facts with opinions. To avoid this, both expert interviews in

various countries and the Delphi panel were used to ensure accuracy of the study in more ways than one. The research was supported by extensive study of legislation and policy documents, which in turn brought objectivity to the interpretation. Inclusion of the various sectors in both interviews as well as through the futures scenarios was again chosen to emphasise the accuracy of the results. Yet, as often stated in the literature, qualitative research is not as duplicable or generalizable as quantitative research, although certain conclusions can be drawn. (Eskola & Suoranta 1998; Varto 2005; Pitkäranta 2010.)

When discussing the importance and the scientific value of this research, it is necessary to point out the recent developments in a society. During the finalising stage of this dissertation, the Finnish legislation has been modified to support the more wide range practices of ecological sanitation. The continuous research to solve the bottlenecks of sustainable sanitation has supported the more positive attitudes towards ecosan, while the ongoing practices have created pressure towards changing the legislation. The change (§41 in 27.6.2014/528) made to Waste Act (646/2011) came to force in September 2014. According to the Act, it is now possible for a property owner to treat the toilet waste created on their property, as well as their neighbour's waste – as long as the treatment remains small scale and is allowed in the municipal environmental regulations. This small step has made the onsite sanitation process easier for many rural inhabitants; another example how practices change policies.

How many people there are who could be described as mere channels for food, producers of excrement, fillers of latrines, for they have no other purpose in this world; they practise no virtue whatsoever; all that remains after them is a full latrine.

Leonardo da Vinci

9. Conclusions

Ecological sanitation has been for a long time a solution for small-scale, on-site sanitation, especially in rural and poor areas. However, with increased awareness, improved technological advances and the simple need for sanitation, it has slowly started to look more and more appealing – to some. Yet, there are obstacles created by lack of knowledge as well as concrete issues which remain to be solved.

Sanitation is a significant issue both globally as well as to an individual. It is important to understand that nearly a third of the world's population has no access to adequate sanitation facilities. The dire need for sanitation becomes apparent at latest once epidemics start spreading and the need for adequate hygiene is realised – both in developing and industrialised countries. As stated in this research, ecological sanitation is linked to other matters than just sanitation; health, education, agriculture and environment, to name a few. This is why it is necessary to study alternative and more sustainable sanitation solutions – and to discover *how* these new solutions could become a more widely adopted practice.

The research was conducted by using various methods and multidisciplinary approach. The innovative aspect of the sanitation institution brought a new view to the discussion on the development of sanitation. Legislation's role in the use of ecological sanitation has not been studied to this extent before, nor has it been linked to practical case studies and expert findings. The Delphi survey (n=44) is also a unique way of examining the future of sanitation. The findings of this research show that practices, policies and attitudes do indeed have their role to play in a changing society – the changing world, in fact – and the results show that however strict a norm can be, the conditions often force change towards the more sustainable methods.

This research finds that the issue of sanitation is linked to several other matters (as indicated in Figure 5), and those links between societal issues ought to be recognised. The results show that institutions, including sanitation, are based on societal norms, which can be changed – but slowly. In general, it can be argued that

needs (such as low sanitation coverage, natural disasters or diminishing phosphorus resources) drive past norms, but following norms seems often to be the easiest course of action: even in the face of need, the change in norms is slow and uncertain.

Yet, there are methods to create the changes and to address the changing needs. As described in Chapter 8, attitudes, policies and practices play an important part in shaping the societal norms. Attitudes change slowly, but increasing awareness causes change – whether it is for alternative sanitation solutions or reuse of toilet waste as fertiliser.

In this dissertation, the main concrete challenges of ecosan appear to be the issue of safety in the utilisation of human waste based fertiliser. Pharmaceuticals and hormones cause concern as there is not enough knowledge on how they behave in the soil or affect crops – yet they are considered safe enough to flow into rivers, lakes and oceans, not to mention our drinking water. Further research on the effects of pharmaceuticals and hormones in terrestrial as well as aquatic ecosystems, in various organisms and in food crops, is required. It is the opinion of the author that the development of biodegradable pharmaceuticals would be beneficial no matter which sanitation system or fertiliser source is used.

As technology develops, more options will become available. Ecological sanitation does not mean (and has never meant) a smelly outhouse and spreading pure excreta or sludge on the fields, but it is about the sensible, safe and sustainable treatment of potentially hazardous waste into a valuable resource. Further study on these technological advances, such as indoor dry toilets, low flush toilets and nutrient recovery methods will be a welcome asset to the development of ecosan. Further research on what issues influence on the adoption and domestication of ecosan is also required, as well as further political research on the decision making process and the requirements of the infrastructure and society in order to further understand the overall development of sanitation practices.

It should not be forgotten that sanitation is still one of the biggest problems faced by humanity as nearly a third of the world's population have no access to proper sanitation. Disease and death cause deterioration in societies, which leads to economic difficulties and further deterioration of the environment. The vicious circle will continue unless it is broken and turned into a virtuous one: by increasing sustainable sanitation methods, such as ecological sanitation, the various sectors of

society can benefit from the few actions that are required. With small investments, great profit can be made – and not only on a financial level.

There is a strong incentive to improve ecological sanitation practices, and to support these practices with policies and legislation. Once the need becomes apparent, the public will realise the potential of ecosan, as long as there is enough information on the success stories – as well as the honest challenges. In time, it is very likely that according to the three pillars of sustainability – economic, ecological and social – ecological sanitation will become the logical choice.

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Noponen Jukka, Sitra
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Sjöblom Annaleena, Kimitoö kommun
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APPENDIX 1: Delphi survey

The survey is presented as it was conducted in Finnish, including the English translation.

Delfoi-kysely ekologisen sanitaation mahdollisuuksista / *Delphi survey on the possibilities of ecological sanitation*

Taustatiedot/ *Background information*

1. Sukupuoli/*Sex*

☐

Mies/*Male*

☐

Nainen/*Female*

*

2. Ikäryhmä/*Age group*

☐

20-35

☐

36-50

☐

51-63

☐

yli 64 /*over 64*

*

3. Tehtävä (voit valita useita vaihtoehtoja)/*Occupation (you can choose multiple options)*

☐

Tutkimus /*Research*

☐

Poliittinen päätöksenteko/*Political decision making*

☐

Media

☐

Järjestötoiminta/*NGO*

☐

Koulutus/*Education*

☐

Maatalous/*Agriculture*

☐

Viranomainen/*Authority*

☐

Yritystoiminta/*Business*

☐

Muu (täsmennä)/*Other (clarify)*

Virtsan lannoitekäyttö/*Fertiliser use of urine*

Vastaa väitteisiin sen mukaan, pidätkö niitä toivottavina ja todennäköisinä tapahtumina. Vasemmalla asteikolla on ehdottomasti ei, oikealle ehdoton kyllä - välipallukat antavat vaihtoehdon vähemmän ehdottomille mielipiteille.

Kommenttikentässä voit perustella vastauksesi tai esittää täydentäviä kysymyksiä tai reunaehtoja väitteille, esimerkiksi mihin vuoteen mennessä muutos tapahtuu tai mitä pitäisi tapahtua sitä ennen.

Vastaat kyselyyn täysin anonymisti. Mikäli kommentteistasi käy ilmi henkilöllisyytesi, ne muokataan nimettömiksi ennen niiden jakelua toisella kierroksella.

Respond to the claims according to whether you consider them desirable and probable or not. On the left side of the scale, is the absolute negative option, while on the right is the absolute yes. In the middle, a less absolute response can be chosen.

In the comment field you can give arguments on your response, ask further questions or specify the time frame or requirements for the change.

Your identity cannot be traced to the questions.

4. Virtsan lannoitekäyttö on sallittua maanparannuksessa. / *The use of urine as fertiliser is allowed in landscaping.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

No / Yes

Probable

Desirable

Comment your response.

5. Virtsan lannoitekäyttö on sallittua ruokakasvien tuotannossa. / *The use of urine is allowed in crops production.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

6. Virtsan lannoitekäytön edistäminen on ensisijainen menetelmä ruokaturvan takaamiseksi kansainvälisellä tasolla. / *The use of urine as fertiliser is the primary method to guarantee food security on an international level.*

	Ei						Kyllä
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Todennäköistä	-3	-2	-1	0	1	2	3
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Toivottavaa	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

7. Virtsan lannoitekäytön terveyshaitat tunnetaan ja niitä voidaan välttää. /*The health issues of fertiliser use of urine are known and can be avoided.*

	Ei						Kyllä
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Todennäköistä	-3	-2	-1	0	1	2	3
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Toivottavaa	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

8. Virtsassa olevien lääkeaineiden ja hormoneiden vaikutus vesistöihin, maaperään ja kasveihin on tiedossa. /*The impact of the pharmaceuticals and hormones found in urine is known both in terms, or waterbodies, soil and plants.*

	Ei						Kyllä
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Todennäköistä	-3	-2	-1	0	1	2	3
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Toivottavaa	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

9. Virtsassa olevien lääkeaineiden ja hormoneiden vaikutus vesistöihin, maaperään ja kasveihin on vältettävissä. /*The impact of the pharmaceuticals and hormones found in urine to waterbodies, soil and plants can be avoided.*

Miten? Kommentoi myös keinoja. /*How? Comment also on the methods.*

	Ei						Kyllä
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Todennäköistä	-3	-2	-1	0	1	2	3
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Toivottavaa	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

10. Myös ulosteen käsittely ja kierrätys on tärkeää, sillä maaperän köyhtyminen on globaali ongelma. /*Also the excreta management and recycling is important due to global soil degradation.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

Tekniikka ja talous /*Technology and economy*

11. Virtsan erotteluteknologiat ovat kehittyneet nesteen keräämisestä pelkkien ravinteiden keräämiseen. /*Urine separation technologies have developed from collecting the liquid to collecting only the nutrients.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

12. Virtsan käytön sijasta fosforin talteenotossa keskitytään yhä enemmän jäteveden puhdistusmenetelmien kehittämiseen ja pohjafosforin talteenottoon. /*Instead of use of urine, more attention is paid towards developing wastewater treatment methods and recovering sedimental phosphorus.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

13. Virtsan lannoitekäytön ohella sitä käytetään myös energianlähteenä tehokkaasti. /*In addition to fertiliser use, urine is also used as an energy source.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

14. Erottelevat kuivakäymälät yleistyvät kotitalouksissa ja julkisissa tiloissa. /*Urine diverting dry toilets are becoming more common in households and public places.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

15. Erottelevien kuivakäymälöiden tyhjennykseen on tarjolla palvelumuotoja niin kotitalouksille kuin suuremmille organisaatioille. / *There are services for emptying urine diverting dry toilets both for households and bigger organisations.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

16. Maatalouden päästöt vesistöihin ovat vähentyneet harkitun lannoitekäytön edistämällä. /*Agricultural runoffs have decreased due to promotion of planned fertiliser use.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

17. Suomi menestyy kansainvälisesti orgaanisen lannoitteen käytössä (esim. laite- ja tuotemyynti, konsultointi). /*Finland is internationally successful in use of organic fertiliser (e.g. product sales, consultation).*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

18. Lainsäädäntöä korjataan kattamaan myös ekologinen sanitaatio ja sen käytännöt (ihmistuotoksen lannoitekäyttö, kuivakäymälät). /*Legislation is being amended to cover also ecological sanitation and its practice (human based fertiliser use, dry toilets)*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

19. Suomi on laatinut fosforin loppumisen varalle kestävän strategian yhteistyössä kaikkien ministeriöiden kanssa. /*Finland has drafted a plan for sustainable use of diminishing phosphorus resources in cooperation with all ministries.*

- Mainitse kommenttikentässä mihin vuoteen mennessä! /-*Mention the year by which this occurs!*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

20. Haja-asustusalueiden päästöt vesistöihin ovat vähentyneet kuivakäymälöiden yleistymisen myötä. /*Runoffs from rural settlement have diminished due to increase in dry toilets.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

21. Suljettu kierto jätevesien osalta toteutuu enenevässä määrin myös taajama-alueilla. /*Closed cycle of wastewater management is reality also in urban areas.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

Koulutus ja osaaminen /Education and knowhow

22. Kestävän sanitaation ammattilaisia koulutetaan Suomessa kestävän vesihuollon ohella. /Professionals in sustainable sanitation are trained in Finland in addition to sustainable wastewater management.

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

23. Kouluviljelmät sekä ruoantuotannon ja ravinnerierron käsittely ovat osa päiväkotien ja alakoulujen toimintaa. /School farming as well as discussing food production and nutrient recycling are a part of activities of kindergartens and primary schools.

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

24. Suomalaisessa korkeakoulussa on sanitaatioalan professuuri. /There is a sanitation professorship in a Finnish university.

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

25. Rakennus- ja talotekniikan ammattilaiset tuntevat kuivakäymäläteknologian ja osaavat suositella laitteita omakotirakentajille ja remontoijille. /Construction and HEVAC professionals are aware of dry toilet technology and can recommend equipment for home builders and renovators.

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

26. Negatiiviset asenteet ja ennakkoluulot ovat tulevaisuudessa suurin haaste suljetun ravinnekierron toteutumiselle. /*Negative attitudes and prejudice are the biggest challenge in the future for closed nutrient cycle to be realised.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

2. kierros: Delfoi-kysely ekologisen sanitaatio mahdollisuuksista *2nd round: Delphi survey on the possibilities of ecological sanitation*

Taustatiedot /*Background information*

1. Sukupuoli /*Sex*

- ☐ Mies /*Male*
☐ Nainen /*Female*

*

2. Ikäryhmä /*Age Group*

- ☐ 20-35
☐ 36-50
☐ 51-63
☐ yli 64 /*over 64*

*

3. Tehtävä (voit valita useita vaihtoehtoja) /*Occupation (you can choose multiple options)*

- ☐ Tutkimus /*Research*
☐ Poliittinen päätöksenteko /*Political decision making*
☐ Media
☐ Järjestötoiminta /*NGO*
☐ Koulutus /*Education*
☐ Maatalous /*Agriculture*
☐ Viranomainen /*Authority*

- ☐ Yritystoiminta /*Business*
- ☐ Muu (täsmennä) /*Other (clarify)*
-

Virtsan lannoitekäyttö / *Fertiliser use of urine*

4. VUONNA 2020, virtsan lannoitekäyttö on yleistä maanparannuksessa, mutta ei vielä käytössä maanviljelyssä. / *In 2020, fertiliser use of urine is common in landscaping but not yet used in agriculture.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

5. Maanviljelijät eivät ole kiinnostuneita virtsan lannoitekäytöstä, koska eivät pidä ravinteiden talteenottoa merkittävänä tekijänä lannoitteen saamiseksi. /*Farmers are not interested in urine fertiliser use because they do not consider nutrient recycling as significant factor in acquiring fertiliser.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

6. Käymäläjätteen lannoitekäyttö lisääntyy vain kehitysmaissa pakon edessä, Suomi ei ole kiinnostunut. /*The fertiliser use of toilet waste increases only in developing countries based on must; Finland is not interested.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3

Kommentoi vastaustasi

Tekniikka ja talous /*Technology and economy*

7. Virtsan hyötykäytön ympärille luodaan erilaisia suomalaisessa yhteiskunnassa toimivia liiketoimintamalleja. */Various business models are being created around fertiliser use of urine.*

Minkälaisista toimintamalleista voisi olla kyse? */What kind of business models?*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

8. Biohajoavien lääkevalmisteiden valmistus lisääntyy ihmisjätteen lannoitekäytön tarpeen myötä. */More biodegradable pharmaceuticals are being manufactured due to increase in demand.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

9. Talopakettien tarjonnassa on jätevesiratkaisuna myös kuivakäymälävaihtoehto. */Dry toilet is an option for ready built houses.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

10. Julkisissa käymälöissä on pääsääntöisesti vedettömiä pisuaareja. */Public toilets have mainly waterless urinals.*

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

11. Suomesta löytyy käymälöitä, joiden käyttäjille maksetaan virtsan lannoitearvoon ja muihin säästyneisiin kuluihin (kuten infra) nähden. */There are toilets in Finland,*

who pay their users for the fertiliser value of urine and other saved expenses (e.g. infrastructure).

Mihin vuoteen mennessä? /By which year?

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

12. Kestävä vesihuolto on uusi koulutusala. Sanitaation ammattilaisia koulutetaan nykyistä enemmän. /Sustainable water management is a new field in education. Sanitation professionals are trained more than today.

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

13. Yksityistaloudet siirtyvät yhä enemmän suljetun kierron jätevesijärjestelmiin, mikä lisää kotitalouskohtaista energiankulutusta ja huolto-ongelmia vanhoihin järjestelmiin nähden. /Private households are adopting more closed cycle wastewater systems, which increases energy consumption and maintenance issues compared to the old systems.

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

14. Maailmanlaajuisesti sanitaation tarpeeseen vastataan yhä enemmän vesivessoja rakentamalla. /The global sanitation need is responded by building more water closed

	Ei						Kyllä
Todennäköistä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Toivottavaa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	-3	-2	-1	0	1	2	3
Kommentoi vastaustasi							

APPENDIX 2: Interview structure

Expert interview

- role regarding sanitation /knowledge of the subject
- practices in the country in question (state level)
 - sanitation
 - nutrient recycling
- challenges in the country in question
 - locally
 - globally
- important actors
 - cooperation
 - coordination
 - governance
- ecological sanitation, opinion on feasibility
 - status in legislation
 - practices (small scale)
 - attitudes
 - obstacles
- future outcomes
- any further contacts to recommend

APPENDIX 3: Programme of the Urine Forum April/2013 (in Finnish, English summary)

English summary

Expert forum on possibilities of fertiliser use of urine

Presentation from MEP Satu Hassi and University lecturer Pirjo Rantanen/Aalto University

Organised by Global Dry Toilet Association of Finland, Aalto University, Pääkaupunkiseudun Kierrätyskeskus and Kokemäenjoen vesistön vesiensuojeluyhdistys ry.

The invitation-only event is meant for experts from various fields, including politicians, researchers, NGO activists and entrepreneurs. The purpose of the forum is to discuss the possibilities and identify the challenges for urine use as fertiliser. The event includes presentation, workshops, and it acts as a basis for a Delphi survey.

Asiantuntijafoorumi virtsan lannoitekäytön mahdollisuuksista

Torstaina 18.4.2013 klo 8:30-12:30

Design Factory, Betonimiehenkuja 5C, Espoo (Aalto-yliopisto, Otaniemi)

Alustukset

Europarlamentaarikko Satu Hassi

Ravinteet talteen ja peltoon - miksi virtsaa tarvitaan lannoitteeksi tulevaisuudessa?

Yliopisto-opettaja Pirjo Rantanen Aalto yliopistosta

Keskitetty jätevesijärjestelmä ja ravinteiden kierrätys

Järjestäjät

Käymäläseura Huussi ry

Pääkaupunkiseudun Kierrätyskeskus Oy

Aalto yliopisto

Kokemäenjoen vesistön vesiensuojeluyhdistys ry

Kutsu

Tarvitsemme nyt Sinun apuasi, hyvä asiantuntija! Kutsumme sinut aamupalalle ja keskustelemaan aiheesta:

Maapallolla on kasvava pula puhtaasta vedestä, ruoasta ja lannoitteista. Suomessa on paljon hyvää teknistä ja koulutuksellista osaamista sovellettavaksi kotimaassa ja vietäväksi maailmalle. Virtsa on tutkitusti erinomainen ja kestävän kehityksen mukainen lannoite, jonka käyttö tulee lisääntymään louhittavan fosforin huvetessa. Nyt on aika aloittaa toimet Suomessa ja EU:ssa virtsan lannoitekäytön mahdollistamiseksi.

Kenelle:

Tilaisuuteen on kutsuttu asiantuntijoita eri aloilta: tutkijoita, poliitikoita, yrittäjiä ja järjestötoimijoita. Jos et pääse itse osallistumaan, ilmoitathan asiasta allekirjoittaneelle. Voit myös ehdottaa tilallesi toista asiantuntijaa.

Foorumi osana väitöstutkimusta

Asiantuntijafoorumi virtsan lannoitekäytön mahdollisuuksista toimii pohjana laajemmalle keskustelulle. Asiantuntijafoorumilla keskustellaan haasteista, ongelmista ja mahdollisuuksista, joita virtsan lannoitekäytöllä on. Aamupäivän aikana ehditään kuitenkin vain raapaista pintaa.

Foorumiin osallistuneilla onkin mahdollisuus osallistua Delfoi-tutkimukseen, joka tehdään foorumin jälkeen kevään ja alkukesän aikana. Tutkimuksessa käsitellään virtsan lannoitekäyttöä edelleen asiantuntijafoorumin keskustelun pohjalta – kaikki asiantuntijoiden vastaukset ja kommentit käsitellään täysin anonyymisti. Tutkimukseen osallistuminen vie muutaman kymmenen minuuttia kolmen kommenttikierroksen ajan, ja se toteutetaan sähköisesti, jolloin vastaaminen onnistuu omalta tietokoneelta.

Delfoi on tutkimusmenetelmä, jota käytetään arvioimaan tulevan kehityksen mahdollisuuksia. Asiantuntijapaneelissa yhdistyvät monialainen tieto ja näkemykset. Osallistujat saavat sähköpostiinsa linkin kyselylomakkeeseen, jossa

vastataan esitettyihin kysymyksiin ja kommentoidaan omia vastauksia (1. kierros huhtikuun loppupuolella). Delfoin toisella kierroksella osallistujien vastaukset avataan anonyymisti lomakepohjaan, jolloin asiantuntijoilla on mahdollisuus kommentoida toistensa mielipiteitä (2. kierros touko-kesäkuussa). Lopuksi kiistanalaisimmat väitteet ja kommentit poimitaan, ja asiantuntijoilla on mahdollisuus vielä kommentoida niitä erikseen (kesäkuussa). Valmistunut ja analysoitu delfoi-tutkimus julkaistaan osana väitöstutkimusta. Osallistujat saavat lukea artikkelin ennen julkaisua.

Ekologisen sanitaation mahdollisuuksista etenkin hallinnon ja lainsäädännön rajoissa tekee väitöskirjaansa Mia O'Neill (HTM; Käymäläseura Huussi ry:n pj) Tampereen teknillisessä yliopistossa. Tutkimus käsittelee kuivakäymälän käytön, ihmistuotoksen lannoitekäytön ja ravinnekierron rajoitteita ja mahdollisuuksia eri kulttuureissa.

Lisätietoja:

Mia O'Neill

mia.oneill@tut.fi

050 3756980

Ohjelma:

Klo 8.30 Aamupalaa tarjolla

Klo 9.00 Tervetuloa! Lyhyt alustus teemaan. Keskustelua, haasteita ja ratkaisuja.

Yhteenveto, tavoitteet tulevaisuudelle.

Klo 10.55 Kahvitauko ja mahdollisuus verkostoitumiseen

Klo 11.15 Työpajat. Yhteenveto

Tilaisuus päättyy n. klo 12.30

Järjestäjät paikalla ja mahdollisuus jäädä keskustelemaan klo 13.30 asti

Lämpimästi tervetuloa edelläkävijöiden joukkoon!

APPENDIX 4: Programme of the Urban Urine Seminar/October 2014 (in Finnish)



1/1

Urbaani urea – työseminaari
MTK:n kokoustilat, neuvotteluhuone 5 ja 6, Simonkatu 6, Helsinki
Torstai 17. lokakuuta klo 10 - 15

OHJELMA

Puheenjohtajana ympäristöjohtaja Liisa Pietola, Maa- ja metsätaloustuottajain Keskusliitto MTK ry.

09.30	Ilmoittautuminen ja kahvit
10:00	Tilaisuuden avaus <i>Liisa Pietola, ympäristöjohtaja, MTK</i>
10:15	Säädökset haasteena ja mahdollisuutena <i>Arja Vuorinen, FT</i>
10:45	Kuivakäymälät osana ruoan tuotantoa - täysi mahdottomuus? <i>Eeva-Liisa Viskari, FT, yliopettaja, Tampereen ammattikorkeakoulu</i>
11:15	Keskustelu ja kommenttipuheenvuorot
12:00	Yhteenveto ja tilaisuuden asiantuntijaosuuden päätös Omakustanteinen lounas, lähistöllä kauppakeskus Forumissa ja Kampissa on runsaasti lounasravintoloita.
13:00	Työpaja Työpajassa on mahdollisuus syventyä kehittämään ja innovoimaan ravinteiden kestävä kierrätystä Suomessa. Työpajan fasilitaattoreina toimivat <i>Käymäläseura Huussin puheenjohtaja ja SYKL:n projektipäällikkö Mia O'Neill</i> sekä Pääkaupunkiseudun Kierrätyskeskuksen ympäristöasiantuntija <i>Kati Hinkkanen</i> .
14:50	Yhteenveto ja tilaisuuden päätös

Seminaariin pyydetään ilmoittautumaan ja samalla ilmoittamaan mahdollisen valmistellun kommenttipuheenvuoron käyttämisestä viimeistään 7.10.2013 Minna Keräselle sähköpostitse osoitteella minna.keranen@mtk.fi.

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nevermore!

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